TROPICAL SCIENCE

THE QUARTERLY JOURNAL
OF THE TROPICAL PRODUCTS INSTITUTE

Volume II · Numbers 1 and 2
1960

LONDON
HER MAJESTY'S STATIONERY OFFICE
PRICE 12s. NET

Tropical Agriculture Series

EDITED BY D. RHIND O.B.E. F.L.S.

Beekeeping in the Tropics

F. G. SMITH D.Sc.

A reference and guide book on tropical beekeeping, with special emphasis on practical and economic aspects. Contents: The biology, behaviour, diseases and enemies, and food plants of bees; man's exploitation of them; economic aspects of beekeeping; construction and equipment of the apiary, and the beekeeper's tools; the most successful techniques of hive management and breeding; beeswax and honey; problems in the development of this industry. 45*s*.

LONGMANS, GREEN & CO. LTD.
6 & 7 Clifford Street, London, W.1

A Selection of

Colonial Research Studies

No. 18 **Iban Agriculture.** A Report on the Shifting Cultivation of Hill Rice by the Iban of Sarawak, by J. D. FREEMAN. **12s. 6d.** (*post* 7*d*.)

No. 21 **Underground Storage of Grain,** by D. W. HALL, G. A. HASWELL, T. A. OXLEY. **2s. 6d.** (*post* 4*d*.)

No. 25 **Exploitation of Sea Birds in Seychelles,** by M. W. RIDLEY and R. PERCY. **12s. 6d.** (*post* 6*d*.)

Obtainable from
HER MAJESTY'S STATIONERY OFFICE
at the addresses on page 114 or through any bookseller

Tropical Science

The quarterly Journal
of The Tropical Products Institute
(*formerly the Colonial Products Laboratory*)

EDITOR:
R. H. KIRBY, B.Com., Ph.D.

ASSISTANT EDITOR:
Miss M. KERSHAW, B.Com.

1960
Volume II, Numbers 1 and 2

LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

Tropical Agriculture Series

EDITED BY D. RHIND O.B.E. F.L.S.

Beekeeping in the Tropics

F. C. SMITH D.Sc.

A reference and guide book on tropical beekeeping, with special emphasis on practical and economic aspects. Contents: The biology, behaviour, diseases and enemies, and food plants of bees; man's exploitation of them; economic aspects of beekeeping; construction and equipment of the apiary, and the beekeeper's tools; the most successful techniques of hive management and breeding; beeswax and honey; problems in the development of this industry. 45*s*.

LONGMANS, GREEN & CO. LTD.
6 & 7 Clifford Street, London, W.1

A Selection of

Colonial Research Studies

No. 18 **Iban Agriculture.** A Report on the Shifting Cultivation of Hill Rice by the Iban of Sarawak, by J. D. FREEMAN. **12s. 6d.** (*post* 7*d*.)

No. 21 **Underground Storage of Grain,** by D. W. HALL, G. A. HASWELL, T. A. OXLEY. **2s. 6d.** (*post* 4*d*.)

No. 25 **Exploitation of Sea Birds in Seychelles,** by M. W. RIDLEY and R. PERCY. **12s. 6d.** (*post* 6*d*.)

Obtainable from
HER MAJESTY'S STATIONERY OFFICE
at the addresses on page 114 or through any bookseller

Tropical Science

The quarterly Journal
of The Tropical Products Institute
(*formerly the Colonial Products Laboratory*)

EDITOR:
R. H. KIRBY, B.Com., Ph.D.

ASSISTANT EDITOR:
Miss M. KERSHAW, B.Com.

1960
Volume II, Numbers 1 and 2

LONDON
HER MAJESTY'S STATIONERY OFFICE
1960

This journal is successor to *Colonial Plant and Animal Products*. Any inquiries concerning articles, etc., in this journal should be addressed to The Editor, Tropical Products Institute, 56-62 Gray's Inn Road, London, W.C.1

VOLUME II · NUMBERS 1 AND 2 · 1960

Contents

Articles

page

EXPERIMENTS IN THE CULTIVATION, HARVESTING AND RETTING OF JUTE IN BRITISH GUIANA
By M. D. ffrench-Mullen 1

THE CONTROL OF JUTE PESTS AND DISEASES IN BRITISH GUIANA
By G. D. Baxter, *Berbice Fibre Research Company Ltd.* . . 36

THE CONTROL OF INSECTS INFESTING GROUNDNUTS AFTER HARVEST IN THE GAMBIA: II. FIELD TRIALS ON THE CONTROL OF THE GROUNDNUT BORER, *CARYEDON GONAGRA* (F)
By A. A. Green, *Pest Infestation Laboratory* 44

THE PRODUCTION AND WORLD TRADE IN FRESH PINEAPPLES
By Mrs. D. E. Kay and E. H. G. Smith 55

THE PRODUCTION OF HARDBOARD FROM TROPICAL TIMBERS: V. MUGONGO (*RICINODENDRON RAUTANENII*)
By D. F. Packman, *Forest Products Research Laboratory* . . 64

Reports of Recent Investigations at the Tropical Products Institute

PULPING TRIALS ON *RICINODENDRON RAUTANENII* TIMBER FROM NORTHERN RHODESIA
By A. E. Chittenden, Miss E. E. L. Edwards and E. R. Palmer 72

PULPING TRIALS ON THREE SPECIES OF PINE FROM MAURITIUS
By A. E. Chittenden and E. R. Palmer 82

DATES FROM THE EASTERN ADEN PROTECTORATE
By P. C. Crowther and E. H. G. Smith 90

PATCHOULI FROM THE SEYCHELLES
By W. S. Matthews and G. B. Pickering 93

DESTRUCTIVELY DISTILLED TURPENTINE FROM CYPRUS
By Miss E. E. L. Edwards and G. E. Howard 97

EXPORTS OF ESSENTIAL OILS FROM THE BRITISH COLONIES FOR 1953-58 99

EXPORTS OF ESSENTIAL OILS FROM THE COMMONWEALTH COUNTRIES FOR 1953-58 101

Notes

THE UNITED KINGDOM MARKET FOR AVOCADO PEARS 103

BOOK REVIEWS. 106

BIBLIOGRAPHY 109

Experiments in the Cultivation, Harvesting, and Retting of Jute in British Guiana

By M. D. FFRENCH-MULLEN

The first part of this article appeared in the previous issue of Tropical Science, *Vol.* 1, *No.* 4.

Harvesting of Jute Seed

The ease with which the ripe seed pod shatters varies considerably between varieties within species and between species. The *olitorius* variety E.C.R.–576 was characterized by having ripe seed pods that did not dehisce when ripe while, at the other extreme, there were *olitorius* varieties found unsuitable for local conditions, the seed pods of which shattered at a touch as soon as they were fully ripe. The other *olitorius* variety, BZ–5, suited to British Guiana was less resistant to shattering than E.C.R.–576 but sufficiently so to be mechanically harvested and to require mechanical threshing. The *capsularis* varieties suitable for fibre production in British Guiana were easier to thresh than the *olitorius* varieties and in this way differed from Indian experience, although the characteristics of jute varieties from India and Pakistan grown in British Guiana bore out the findings in India that *olitorius* jutes shattered more easily than *capsularis* jutes.

Higher yields of good quality fully ripe seed of all varieties could be obtained by hand harvesting the pods as they matured in the field. The work was done by women and the cost averaged $1.06 per lb. of seed with yield of 350-400 lb. per acre.

Advantage was taken of the resistance to shattering characteristic of E.C.R.–576 and BZ–5 to cut the seed crop, when fully ripe, by tractor-mounted mower, to bundle the stems for transport to the drying lines and to stand them up between the lines. Following two or three days wilting, the stems were ribboned, the seed roughly separated from the shive and ribbon, sun-dried for two or three days, winnowed and sun-dried for a further two days down to a moisture content of about 8 per cent. Afterwards, the seed was stored in airtight metal drums inside weatherproof, storage bonds. If the seed was found to be badly infected with fungus because of rain wetting the mature pods before harvest, it was found desirable to float off light seed after winnowing, extend the period of sun-drying and to treat the seed with a seed dressing such as 'Agrosan GN' prior to storage. This harvesting technique could be extended to the *capsularis* varieties provided that one was prepared to accept the considerable loss of seed involved even when harvesting took place when the pods were fully mature but not ripe. To avoid a volunteer crop and the loss of seed all *capsularis* varieties were hand harvested.

The mowing of a seed crop was done with a Ferguson mid-mounted tractor mower. The stems were collected by hand into bundles, transported by trailer fitted with hayladders to the drying lines and, after a few days wilting, to a ribboner situated preferably on a concrete floor. The downstriker ribboner is more suitable for this purpose, as seed, shive and ribbon is discharged downwards on to the floor. With the replacement of the downstriker ribboner with the upstriker (Plate XIII), it was found that the upstriker would do quite well as a thresher, provided a deflector was placed over the top of the beater drum to deflect the seed downwards to the floor. Germination tests indicated that the viability of the seed was not affected by ribboning.

An alternative to the use of the ribboner was to thresh the crop by running pneumatically-tyred tractors over stems stacked on a concrete floor or on tarpaulins in the field. The cost of this method, excluding depreciation and maintenance, was 9¼ cents per lb. of seed compared with ribboner threshing costing three cents per lb.

Sun-drying proved quite satisfactory. It was essential for the seed to be well dried before storage; otherwise there would have been a fall in seed viability. Clean seed dried to around 8 per cent. moisture and then stored under cover in airtight drums such as 4 gal. or 44 gal. petrol and oil drums maintained viability for four years, with only a small loss in the germination percentage. Similar seed placed in cold storage in airtight drums maintained viability for six years without any loss. Seed infected by fungus without flotation treatment and a seed dressing would have become worthless in two years.

Seed yields varied considerably from 150-700 lb. per acre depending on cultivation conditions, weather at harvest and the incidence of cercopids. In autumn crops, the hand picking of the BZ *capsularis* varieties generally extended from October to the end of December. The machine harvesting of BZ–5, an *olitorius* variety, generally took place during the period late November to early January, while the cutting of an E.C.R.–576 seed crop did not take place until January or later. If hand harvesting was resorted to for the *olitorius* varieties, BZ–5 was harvested over the same period as the BZ *capsularis* varieties while the harvesting of E.C.R.–576 would begin in late November. As the rainy weather would occur from late November onwards, the quality of seed was adversely affected, that of E.C.R.–576 more than any other variety. A similar situation with regard to weather applied to the spring crop plantings of the BZ *capsularis* varieties for seed. BZ–5 and E.C.R.–576, if planted in November, would start to flower in December and seed yields would be very low although the seed might be harvested in dry weather if the March-April dry season eventuated. A seed yield of 400 lb. per acre would be considered reasonable.

Table XIII compares the costing of various methods of harvesting jute seed described, excluding depreciation and maintenance and including winnowing and drying.

TABLE XIII

Operation	Cost per acre $ c.	Cost per lb. $ c.	Man hours per acre
1. Hand harvesting . . .	84 56	1 06	363·84
2. Cutting with mower, threshing with a ribboner, etc. .	53 25	0 27	175·41
3. Cutting with mower, threshing with tractor, etc. . .	55 12	0 33	182·20

Assuming a yield of 400 lb. per acre of seed, the cost per lb. of seed produced, including cultivation, fertilization and harvesting costs by the above three methods of harvesting, maintenance of all machinery, and overheads, but excluding depreciation, amounted to $1.71 when the crop was hand harvested and threshed, 90 cents when the crop was cut by mower and threshed by the ribboner, and 93 cents when cut by mower and threshed with a tractor. Being a research company, overheads were high, amounting to 29 cents per lb. of seed.

Harvesting of Other Crops

(a) Rice

The system of growing rice on beds 25 ft. wide presented no harvesting problems. The rice was cut by women using sickles and was threshed on tarpaulins on the beds by running pneumatically-tyred tractors over the sheaves spread on the tarpaulin. This was found to be more economic at Enterprise than any other method of threshing tried out, which included hand threshing on a trestle table, the transport of the sheaves to a concrete drying floor by trailers and subsequent threshing by the wheels of a tractor. It was decided at Enterprise that rice grown on a bed system could be combine-harvested and that a self-propelled combine would be most suitable. This could not be confirmed by field tests as a combine was not available. At the Central Agricultural Station the use of a small thresher on the beds and a trailed combine used as a thresher on the dam bed reduced the cost of harvesting. It was found that a mid-mounted mower can be used to cut the crop, if it is not badly lodged, with a consequent reduction in cutting costs. Care has to be exercised with a mower if field losses of grain are not to become excessive in varieties with a tendency to shatter. This may result in a serious weed problem due to volunteer rice in the following jute crop.

Ample proof was obtained, both at Enterprise and at the Central Agricultural Station, that the yields of paddy obtained from growing rice on a bed layout as either an autumn or spring crop were generally higher than average compared with the traditional rice field layout, probably owing to better cultivation and water control. At Enterprise, mean yields on a field basis varied from 17 to 20½ bags (140 lb. net) per acre while, in statistical trials testing rates of application of fertilizers, plot yields of up to 28½ bags per acre were obtained. At the Central Agricultural Station in 1957 and 1958, staff of the Department of Agriculture

tested this system of planting rice on beds developed by the company and obtained confirmation of the results obtained at Enterprise during 1954-56.

(b) Cowpeas

The yield of the cowpea variety 'mottled brown' when planted as a broadcast crop was affected by seed rate, weed competition, weather conditions and, to a less extent, pests. In the 1956 spring crop, yields on a bed layout on clay soils at Enterprise varied from 336-692 lb. per acre while, if the edges of the beds where the crop had been destroyed by flooding were discounted, yields per acre rose to 1,039 lb.

In the 1957 autumn crop at the Central Agricultural Station on deep sand and pegassy soils, yields averaged 310 lb. per acre for a crop of 55 acres. However the yields on beds dressed with agricultural lime varied from 775 to 1,550 lb. per acre. Similarly, yields for the 1958 spring crop on the same area over 70 acres varied from 311 to 791 lb. per acre.

The crop was picked by hand at an average cost of $19.17 per acre requiring 81·31 man-hours per acre. Picking was carried out by women. Threshing was subsequently carried out either on a concrete drying floor or on tarpaulins on the dam bed using the wheels of a tractor such as the Ferguson. Average costs for this method of threshing were $4.65 per acre, 16·93 man-hours per acre being necessary. Sun-drying of the seed was carried out on a concrete floor or tarpaulins, winnowing being done by hand either in the wind or in a blast of air from an engine driven fan, the latter being more efficient. Average costs for drying and winnowing were 28 cents per acre, the labour requirement being 1·03 man-hours per acre.

Owing to the high cost of hand harvesting, trials were conducted into the possibility of cutting the crop by hand or mower and threshing it in a stationary thresher. Field losses tended to be heavy and so a Case trailed rice combine was tried out towed by a Fowler 'VFA' tractor. The combine successfully harvested 60 per cent. of the crop; the 40 per cent. left on the field had to be gleaned by hand, and the gleanings were threshed by tractor as was customary.

TABLE XIV

Operation	Cost per acre $ c.	Man hours per acre	Operation	Cost per acre $ c.	Man hours per acre
Hand picking .	19 17	81·31	Harvesting by combine .	4 39	7·75
Threshing with with tractor	4 65	16·93	Gleaning after combining .	12 43	51·44
Drying and winnowing .	0 28	1·03	Threshing gleanings with tractor	0 82	1·61
			Drying and winnowing .	4 35	15·31
Total . .	24 10	99·27	Total . .	21 99	76·11

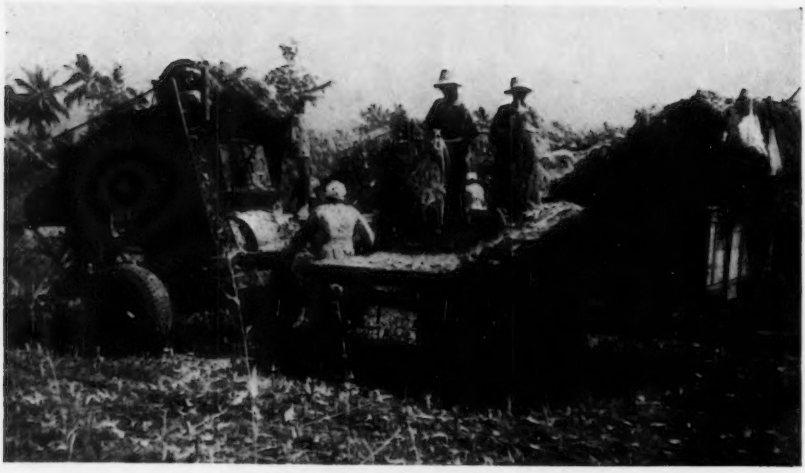


PLATE XIII. The modified Elcom ribboner

PLATE XIV. Lowering nests of grids into retting tanks

[facing page 4

The combine produced seed suitable for sale as a pulse. There were more broken seeds and immature seeds in the seed produced by the combine. No doubt this could be improved in time by adjusting the design of the combine. The average cost of the two systems of harvesting are compared in Table XIV. No doubt further reductions in cost by using a combine could be obtained with further experimentation.

(c) Maize

The crop was hand harvested and yields at Enterprise were disappointing in view of the excellent crop growth, owing to pests and unseasonable rain at silking. Unfertilized beds yielded 1,471 lb. of dry cobs per acre while beds receiving an NPK fertilizer yielded 2,879 lb. of dry cobs per acre. It was concluded that maize showed some value as a rotation crop with jute but that returns would depend on the vagaries of the weather and the pest complex. This was again demonstrated at the Central Agricultural Station for the 1958 spring crop, when yields varied from only 663 to 827 lb. of dry grain per acre on deep sand soils, owing to pest attacks which it was not economically possible to control.

(d) Cotton

This was hand picked by women and, once trained, their rate of picking equalled that of women pickers in the West Indies. Yields were invariably poor due to the effect of weather either on growth, boll shedding or by damage to the seed cotton at harvest. It was concluded in 1954 that, as there were so many other areas in which cotton grows satisfactorily, to try and re-establish cotton on the coastal clays of British Guiana under unfavourable weather conditions was unnecessary.

III. Fibre Extraction

Retting

Following retting experiments at Mokwa in 1950, it was concluded that there was no difficulty in retting either green or dry ribbon of *Hibiscus cannabinus*. In planning the programme of work for the Company in 1951/52, it was not anticipated that retting dry or green jute ribbon would offer any difficulty in the light of the Mokwa results with *H. cannabinus*. In the event, this assumption proved incorrect and the problems involved in retting ribbon, in particular dry ribbon, with precision and uniformity were not finally solved until September 1954 when the conditions necessary to produce clean, well-retted fibre had been sufficiently determined to permit routine retting. Thereafter, retting became a routine operation, improvements being confined to handling techniques and tank design with a view to increasing the efficiency of retting and the lowering of retting costs.

Retting installations at Enterprise comprised four wood-lined retting tanks sunk into clay soil with a fairly high silt content on the banks of the Canje river, and four concrete experimental tanks. The description of the design and fittings of these tanks that follows, relates to the tanks as they were finally set up after the retting problem had been solved in

1954. The tanks were 25 ft. × 12 ft. × 8 ft. deep, with vertical end walls and sloping sides giving dimensions at the bottom of the tank of 25 ft. × 8 ft. The floor of the tank sloped gently to a concrete sludge sump 2 ft. wide across the full width of the tank at one end. The water intake valve was situated at the end of the tank opposite to the sludge sump; so also was the air intake pipe which fed a grid of aerator pipes supported 4 to 6 in. from the bottom of the tank. The tank was lined with tongue and groove greenheart (hardwood) and surrounded at the surface by a reinforced concrete floor to which the woodwork of the tank was tied. A beam was attached to the inside of the top of the tank along either side, under which were placed cross beams to hold the nest of grids on which ribbon was laid below the surface of the retting liquor. The grids were made of 2 in. × 2 in. or 2 in. × 1½ in. greenheart slats at 2½ ft. to 2¾ ft. centres running the length of the tank with 4 in. × 2 in. cross-members at suitable intervals, the ribbon being laid across the slats at right angles to them. The number of grids in the tanks at any one time depended on the amount of ribbon being loaded. There were, however, never more than twelve including the top holding-down grid which cannot be loaded. The internal measurements of the concrete experimental tanks were 7 ft. × 7 ft. × 5 ft. deep. These tanks were fitted out in a similar manner to the earthern tanks as regards aeration, piping, water intake and grids The grids were held below the surface by removable cross beams secured by bolts set into the top of the walls of the tanks Water for retting was supplied by a middlewalk and was pumped into the tanks as required This middlewalk was also available for retting experiments. Aeration was effected by pumping air at 5 lb. per sq. in. at a rate of not less than 2¼ cu. ft. of air per hour per lb. of dry ribbon for one hour in the morning and one hour in the afternoon each day during retting.

Following the construction of the wood-lined earthen tanks, retting was started early in 1953. By the middle of the year, it was clear that it was impossible to ret dry ribbon when loaded into tanks in trusses made up of stricks with ribbon to liquor ratios of 1 : 25 to 1 : 50. It was also found impossible to ret ribbon in trusses immersed in the middlewalk. The problem was put before the Colonial Microbiological Research Institute in Trinidad, The British Jute Trade Research Association in Dundee, H. M. Flax Establishment in Norfolk, and the Tropical Products Institute in London, the first three organizations being sent dry ribbon for retting trials. All four organizations were most helpful but in the event the problem was solved at Enterprise. The conditions under which dry and green ribbon could be got to ret were determined in the laboratory using glass jars. Rets were laid down in the concrete or wood-lined earthen tanks at Enterprise under conditions dictated by the laboratory findings and, in this way, the various factors controlling the retting of ribbon particularly dry ribbon were determined and a technique developed permitting the Company to ret on a routine basis. Solving this problem involved 18 rets (in most cases with 10 or more treatments) in the laboratory and eleven field rets at Enterprise in 1953. There were also six laboratory and 50 field rets up to September 1954 before a satisfactory

technique was developed. Subsequently no difficulties were experienced in routine retting, as was shown by the fact that 50 routine rets were successfully carried out during the remainder of 1954, 168 rets in 1955 and 235 rets in 1956 at Enterprise. With retting times standardized at five to seven days, no difficulties were encountered in 1957 or subsequently at the Central Agricultural Station.

The factors examined during trials leading to the solution of the retting problem and their effect on retting are described below:

(a) Water for Retting

The water available for retting on the coastlands of British Guiana is that used for irrigation purposes. It is drawn from the conservancies or rivers and is light brown in colour. Middlewalk water may be slightly turbid on occasions when the canal is being used for transport purposes and is generally less acid than water taken directly from the rivers, save when, owing to tidal action, the river water contains salt during dry weather. The water probably contains organo-acids due to its passage over pegasse and the vegetation in the canal as well as iron. All fibre produced with such water tends to be tinted a silver grey or brown, the more stagnant or slow moving the water used for retting, the deeper the silver-grey or brown-staining of the fibre. Filtered artesian well water did not stain the fibre but slowed up retting.

(b) Dry Ribbon to Liquor Ratio

The ratio of dry ribbon to retting water or liquor in the tank was studied when it was found that retting could not be carried out satisfactorily with ratios of 1 : 25 to 1 : 50. It was found that a dry ribbon to liquor ratio of 1 : 125 was essential for quick and satisfactory retting. The ratio of dry ribbon to green by weight is 1 : 4. If green ribbon was to be retted the capacity of the tank for dry ribbon was multiplied by four and this weight of green ribbon was loaded into the tank. The out-turn of fibre from any given weight of clean dry ribbon retted varied, but can be taken to be half the weight of dry ribbon retted or one-eighth of the weight of green ribbon retted. It would appear that, with narrow ribbon to liquor ratios, the by-products of bacterial action inhibit continued activity of the bacteria with the result that retting slows up and, on some occasions, almost stops.

(c) Maturity of Ribbon

This undoubtedly has an effect on the speed of retting and the cleanliness of the fibre, both of which affect quality. The more overmature a crop is at ribboning the longer it takes to ret and the more difficult it is to obtain clean ribbon without overretting and so weakening the fibre. The butt or root ends of ribbon are generally lignified in an overmature fibre crop and will never ret clean.

(d) Variety

There appear to be differences between varieties in their speed of retting particularly as dry ribbon. The varieties BZ–1 and 104, which

1954. The tanks were 25 ft. × 12 ft. × 8 ft. deep, with vertical end walls and sloping sides giving dimensions at the bottom of the tank of 25 ft. × 8 ft. The floor of the tank sloped gently to a concrete sludge sump 2 ft. wide across the full width of the tank at one end. The water intake valve was situated at the end of the tank opposite to the sludge sump; so also was the air intake pipe which fed a grid of aerator pipes supported 4 to 6 in. from the bottom of the tank. The tank was lined with tongue and groove greenheart (hardwood) and surrounded at the surface by a reinforced concrete floor to which the woodwork of the tank was tied. A beam was attached to the inside of the top of the tank along either side, under which were placed cross beams to hold the nest of grids on which ribbon was laid below the surface of the retting liquor. The grids were made of 2 in. × 2 in. or 2 in. × 1½ in. greenheart slats at 2½ ft. to 2¾ ft. centres running the length of the tank with 4 in. × 2 in. cross-members at suitable intervals, the ribbon being laid across the slats at right angles to them. The number of grids in the tanks at any one time depended on the amount of ribbon being loaded. There were, however, never more than twelve including the top holding-down grid which cannot be loaded. The internal measurements of the concrete experimental tanks were 7 ft. × 7 ft. × 5 ft. deep. These tanks were fitted out in a similar manner to the earthern tanks as regards aeration, piping, water intake and grids The grids were held below the surface by removable cross beams secured by bolts set into the top of the walls of the tanks Water for retting was supplied by a middlewalk and was pumped into the tanks as required This middlewalk was also available for retting experiments. Aeration was effected by pumping air at 5 lb. per sq. in. at a rate of not less than 2¼ cu. ft. of air per hour per lb. of dry ribbon for one hour in the morning and one hour in the afternoon each day during retting.

Following the construction of the wood-lined earthen tanks, retting was started early in 1953. By the middle of the year, it was clear that it was impossible to ret dry ribbon when loaded into tanks in trusses made up of stricks with ribbon to liquor ratios of 1 : 25 to 1 : 50. It was also found impossible to ret ribbon in trusses immersed in the middlewalk. The problem was put before the Colonial Microbiological Research Institute in Trinidad, The British Jute Trade Research Association in Dundee, H. M. Flax Establishment in Norfolk, and the Tropical Products Institute in London, the first three organizations being sent dry ribbon for retting trials. All four organizations were most helpful but in the event the problem was solved at Enterprise. The conditions under which dry and green ribbon could be got to ret were determined in the laboratory using glass jars. Rets were laid down in the concrete or wood-lined earthen tanks at Enterprise under conditions dictated by the laboratory findings and, in this way, the various factors controlling the retting of ribbon particularly dry ribbon were determined and a technique developed permitting the Company to ret on a routine basis. Solving this problem involved 18 rets (in most cases with 10 or more treatments) in the laboratory and eleven field rets at Enterprise in 1953. There were also six laboratory and 50 field rets up to September 1954 before a satisfactory

technique was developed. Subsequently no difficulties were experienced in routine retting, as was shown by the fact that 50 routine rets were successfully carried out during the remainder of 1954, 168 rets in 1955 and 235 rets in 1956 at Enterprise. With retting times standardized at five to seven days, no difficulties were encountered in 1957 or subsequently at the Central Agricultural Station.

The factors examined during trials leading to the solution of the retting problem and their effect on retting are described below:

(a) Water for Retting

The water available for retting on the coastlands of British Guiana is that used for irrigation purposes. It is drawn from the conservancies or rivers and is light brown in colour. Middlewalk water may be slightly turbid on occasions when the canal is being used for transport purposes and is generally less acid than water taken directly from the rivers, save when, owing to tidal action, the river water contains salt during dry weather. The water probably contains organo-acids due to its passage over pegasse and the vegetation in the canal as well as iron. All fibre produced with such water tends to be tinted a silver grey or brown, the more stagnant or slow moving the water used for retting, the deeper the silver-grey or brown-staining of the fibre. Filtered artesian well water did not stain the fibre but slowed up retting.

(b) Dry Ribbon to Liquor Ratio

The ratio of dry ribbon to retting water or liquor in the tank was studied when it was found that retting could not be carried out satisfactorily with ratios of 1 : 25 to 1 : 50. It was found that a dry ribbon to liquor ratio of 1 : 125 was essential for quick and satisfactory retting. The ratio of dry ribbon to green by weight is 1 : 4. If green ribbon was to be retted the capacity of the tank for dry ribbon was multiplied by four and this weight of green ribbon was loaded into the tank. The out-turn of fibre from any given weight of clean dry ribbon retted varied, but can be taken to be half the weight of dry ribbon retted or one-eighth of the weight of green ribbon retted. It would appear that, with narrow ribbon to liquor ratios, the by-products of bacterial action inhibit continued activity of the bacteria with the result that retting slows up and, on some occasions, almost stops.

(c) Maturity of Ribbon

This undoubtedly has an effect on the speed of retting and the cleanliness of the fibre, both of which affect quality. The more overmature a crop is at ribboning the longer it takes to ret and the more difficult it is to obtain clean ribbon without overretting and so weakening the fibre. The butt or root ends of ribbon are generally lignified in an overmature fibre crop and will never ret clean.

(d) Variety

There appear to be differences between varieties in their speed of retting particularly as dry ribbon. The varieties BZ–1 and 104, which

produce coarse fibre, ret more easily, whether as green or dry ribbon and no difficulty is experienced in retting ribbon of these varieties even when very overmature. The *capsularis* varieties tend to ret more easily than the *olitorius* varieties. The overdrying of ribbon on the drying lines had the effect of making the production of clean fibre more difficult without overretting and therefore weakening the fibre. Overdried ribbon was a less serious problem with varieties that were easier to ret.

(e) Freedom of Ribbon from Shive

One of the major factors in retting ribbon is the need for the ribbon to be free from entangled and, particularly, adhering shive when retted. Entangled shive comprises sections of pith caught in the ribbon at ribboning. The bulk of this falls out on the drying lines and in handling. Adhering shive comprises the unribboned butts of stems from the ribboner and any piece of pith adhering to or cemented to the bark which has not been torn away from the bark during ribboning. The proportion of adhering shive in ribbon increases as the crop gets progressively more overmature for fibre production.

The effect of adhering and, to a lesser degree, of entangled shive is to reduce the surface area of the ribbon available for attack by the retting bacteria. The result is uneven retting in any one length of ribbon with a reduction in fibre quality. Retting of the crop end of the ribbon is more rapid than at the butt end. If the retting of the latter is further slowed up by shive, the top end of the ribbon, even if it contains 'papery' shive, is often ruined by overretting before the butt ends are retted. It is of paramount importance when retting green or dry ribbon, that the ribbon be free of all shive if a uniform quick ret is to be obtained. The realization of this requirement necessitated the development of a scutcher, superseded by the machine comb, as well as the replacement of downstriker ribboners by upstrikers and the making of every effort at harvest to avoid having to ribbon crop that was overmature.

(f) Packing of Ribbon

The method of packing the ribbon in the retting tank was found to be of major importance. Dense packing inhibited retting. Retting dry ribbon was first tried out by packing the stricked ribbon in trusses built into the tank in the form of a raft, with ribbon to liquor ratios of 1 : 25 to 1 : 50. The ribbon on the outside of the raft retted but not at the stricking point where the ribbon was densely packed at the twist. The rest of the ribbon in the raft did not ret properly and the degree of retting was very variable. This applied whether the trusses were packed horizontally or vertically. Stricks of ribbon loosely tied at one or two points and laid out flat and untwisted in the form of a raft, each layer separated by lengths of bamboo, retted better than when the ribbon was packed in trusses but was still unsatisfactory, there always being less retting of the ribbon near the tie. The problem was finally solved by laying untied stricks of ribbon, one layer deep, full-length across a grid. Each layer of ribbon was separated from adjacent layers by a layer of water, the top of each grid being about 6 in. above the one below it. It was important that the

twist be taken out of the strick before it was laid across the bars of the grid. Further the butts of the ribbon in any one layer were laid at the opposite side of the grid to that of the layers immediately above or below it.

(g) Aeration

This involves the blowing of air at low pressure (5 lb. per sq. in. for an hour twice daily was found suitable) into a tank. The air is distributed over the bottom of the tank by means of a series of pipes with fine holes drilled underneath the pipes. The air is released in the form of small bubbles which rise to the surface through the ribbon lying on the grids. The effect of this air movement appears to be, primarily, the agitation of the retting liquor and its circulation in the tank and, secondly, oxidation and is essential for efficient retting. The escape of the gaseous by-products of retting is assisted by aeration.

The circulation of retting liquor within the tanks by portable pumps was found to be of little use and more costly than aeration. The aeration of a proportion of the retting liquor by pumping it over a wooden cascade erected over the tank had no effect. The failure of these two methods was attributed to insufficient agitation and circulation of the liquor as compared with aeration.

The amount of air pumped into a ret does not appear to be particularly critical providing that the distribution is suitable. The amount of air required can be calculated on the basis that, for each pound of dry ribbon loaded, $2\frac{1}{4}$ cu. ft. of air per hour at 5 lb. per sq. in. will be required twice daily, dispensed by $1\frac{1}{4}$-in. distribution pipes placed at 3 ft. intervals across the bottom of the tank with $\frac{3}{16}$-in. holes drilled at 6 in. centres in the bottom of these pipes. The distribution pipes are fed from a centrally-placed 2-in. pipe and have their ends plugged. Trials carried out with single and double aeration pipes down the long axis of the tank were not as effective in speeding up the ret and, moreover, resulted in the fibre becoming entangled. It is necessary that the line of air bubbles released by any air distribution pipe should rise parallel to the length of the ribbon and not across it. In the latter case, serious entanglement of the fibre results.

(h) Addition of "Starter"

Adding 'starter' means to transfer a certain amount of retting liquor from an active ret to a new ret, after the tank has been loaded but before it is filled with water. The starter can be added towards the end of filling provided the tank is well aerated on completion of filling. It was found that the addition of about 10 per cent. of the total volume of liquor required for a retting tank of a starter from an active ret had the effect of speeding the increase of bacteria and consequently of retting. The most suitable starter was liquor that had been in ret for three to four days when still turbid and yellow. Liquor from a ret being discharged can be used as a starter but is not as quick in building up bacteria as liquor from an active ret.

(i) Addition of Nitrogen and Other Chemicals

Information was received that the addition of sulphate of ammonia to rets of *Hibiscus cannabinus* in Mexico had been found to speed up retting. This was confirmed by the British Jute Trade Research Association working with jute ribbon supplied by the Company, but there was some doubt as to whether the addition of this chemical would affect fibre quality. Laboratory rets indicated that when sulphate of ammonia was added to a ret at a rate of either 1 per cent. or 2 per cent. by weight of green ribbon or its equivalent in dry ribbon, retting was accelerated. The fibre produced had a golden colour unless heavily stained by iron. The fibre also felt a trifle harsher than fibre retted without the addition of sulphate of ammonia. Field rets confirmed the value of sulphate of ammonia in speeding up retting and no obvious deleterious effects could be found in the fibre so produced.

Other sources of nitrogen were tested in the laboratory using the standard fertilizers, ammonium nitrate and urea. The rate of applications tested was equivalent in weight of nitrogen to those used for sulphate of ammonia. The use of urea containing 46 per cent. N at rates of 0·43 per cent. and 0·86 per cent. of urea by weight of green ribbon loaded or its equivalent in dry ribbon (4 lb. of green ribbon give 1 lb. of dry ribbon) resulted in the ret being discharged one to three days earlier than comparative rets with sulphate of ammonia and the yellow fibre colour peculiar to the latter chemical was not obtained. This beneficial effect of urea was confirmed in field rets and it was added to all rets from the middle of 1954 at rates of either 0·215 per cent., 0·43 per cent. or 0·86 per cent., the higher rates giving cleaner fibre but requiring greater care to avoid overretting. From 1955, the addition of urea at the rate of 0·86 per cent. by weight of green ribbon or its equivalent in dry ribbon was adopted as standard practice.

Laboratory trials with other cheap chemicals such as hypo, phosphates and calcium were unsuccessful. The use of wetting agents such as 'Agral LN' were tried and proved of little use.

(j) Insect Damage to Ribbon

Bark that had been damaged by flea beetles during growth developed oval grey-brown spots of callous tissue on the surface and it was found that, in retting, these spots of callous tissue did not ret or retted much more slowly than undamaged tissue. The result was a specky fibre, particularly if the fibre was underretted rather than overretted. The only solution to this problem was the control of flea beetles in the crop. The fibre under the spots was not damaged.

Ribbon that had been stored for over three years before retting and had been attacked by insects was found to be very weak. There was no sign of fungal damage. All ribbon in store for 12 months prior to retting did not appear to be affected by insect damage.

(k) Temperature of Retting Liquor

Considerable work was done in 1953 and 1954, over a period of a year, to record the temperatures of liquors during retting at various

depths in the tanks and at different times of day, as well as the daily range of temperatures within the tanks. The temperatures recorded and the variation in the daily range between temperatures 4 to 6 in. below the surface and at a depth of 5 ft. did not appear to interfere much with retting Undoubtedly, the top two layers of the ret, particularly the top layer, always retted a trifle faster than the bottom layers but the difference was not such as to justify the top layers being discharged say a day or even half a day before the bottom layers As a general rule it is better to err on the side of underretting rather than to produce over-retted weak fibre. In consequence, this slight temperature effect can be used to some purpose as the retter can be instructed to discharge the ret when the top two layers are fully retted. It is thus possible to ensure that the bulk of the fibre discharged will not be overretted. This does not mean that a retter should make his decision as to whether to discharge a ret or not only on samples taken from the two top layers. He should always check the ret by examining samples withdrawn from a layer at least 3 ft. below the surface of the water. Under the temperature conditions prevailing throughout the year in British Guiana it did not appear necessary to consider heating the retting liquors artificially. Raising the temperature of retting liquor by even a few degrees and maintaining such a temperature for the duration of the ret would be very costly, both directly and indirectly, due to the alterations in tank design which would be necessary particularly at ribbon to liquor ratios of 1 : 125. In addition to field observations indicating that raising liquor temperatures a few degrees was unnecessary, confirmation that this view was correct was obtained in specific laboratory rets. These were designed to test whether the retting of ribbon at a constant temperature equal to that reached on a hot day in the surface layers of rets in the open, speeded up retting.

Table XV records the mean temperatures encountered in aerated or stagnant rets at Enterprise near the surface of the liquor in the early morning, at noon, and in the afternoon throughout the year Temperatures were recorded daily throughout each ret. In this table three types of retting tanks are referred to. The wood-lined earthen tank has already been described and means a tank sunk in the ground the walls and floor of which are sheathed in wood. The concrete tanks have also been described. The earthen tank consisted of a tank excavated out of the ground, the walls of which were sheathed in wood, the floor of the tank being earth. This tank was 110 ft. × 12 ft. × 4 ft. deep.

TABLE XV

Ret no.	Month	Type of tank	Duration of ret in days	Aerated or stagnant	Depth in inches at which temperatures were recorded	Mean Temperatures in Degrees Centigrade					
						POINT A			POINT B		
						7 a.m.	noon	4 p.m.	7 a.m.	noon	4 p.m.
1/54	Jan./Feb.	Earthen	31	Stagnant	6	25·6	28·0	28·9	—	—	—
2/54/A	,,	Concrete	27	,,	6	25·6	27·2	28·0	—	—	—
2/54/B	,,	,,	27	,,	6	25·7	27·4	28·4	—	—	—
1/53	Feb./Mar.	Wooden	37	,,	4	28·0	—	—	27·9	—	—
2/53	March	,,	27	Aerated	4	29·8	—	—	29·8	—	—
3/53	Mar./Apr.	,,	47	Stagnant	4	29·1	—	—	29·3	—	—
4/53	,,	,,	27	,,	4	28·6	—	—	28·7	—	—
5/53	May/June	,,	40	Aerated	6	28·4	—	—	28·6	—	—
6/53	August	,,	15	,,	6	29·2	32·1	29·7	—	—	—
7/53	Sept./Oct.	,,	23	,,	6	29·1	32·3	30·1	29·0	32·1	30·1
8/53	,,	,,	21	Stagnant	6	28·0	33·5	32·8	28·0	33·3	32·8
9/53	,,	,,	33	,,	6	28·4	33·8	33·2	28·2	33·7	33·1
9/53	,,	,,	33	Aerated	6	28·2	33·4	31·8	29·4	33·9	31·2
10/53	Nov./Dec.	,,	32	Stagnant	6	27·4	32·5	30·9	27·4	32·5	30·9
11/53	Dec./Jan.	,,	19	,,	6	26·3	29·8	29·7	26·4	29·8	29·7
General Mean						27·8	31·0	30·4	28·4	32·6	31·3
Mean of readings from wooden tanks only						28·4	32·5	31·2	28·4	32·6	31·3

Table XVI records the mean temperatures in three stagnant rets at three depths below the surface of the liquor thrice daily during the life of the ret. Particulars of the rets can be obtained by reference to Table XV.

TABLE XVI

Ret no.	Mean Temperatures in Degrees Centigrade								
	7 a.m.			Noon			4 p.m.		
	6 in.	2 ft.	4 ft.	6 in.	2 ft.	4 ft.	6 in.	2 ft.	4 ft.
1/54	25·6	25·5	25·5	28·0	26·2	26·2	28·9	26·4	26·2
2/54/A	25·6	25·6	25·6	27·2	26·5	26·2	28·0	26·6	26·3
2/54/B	25·7	25·7	25·7	27·4	26·6	26·5	28·4	26·7	26·6

Table XVII gives the mean maximum and minimum thermometer readings recorded daily during retting at various depths from the surface of the retting liquor.

TABLE XVII

Ret no.	Mean Temperatures in Degrees Centigrade								
	6 in. Below Surface			3 ft. Below Surface			5 ft. Below Surface		
	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.
5/53	31·5	26·9	4·6	—	—	—	29·2	27·4	1·8
6/53	31·7	27·2	4·5	—	—	—	29·3	27·6	1·7
7/53	29·6	27·4	2·2	—	—	—	29·3	27·7	1·6
8/53	—	—	—	—	—	—	28·3	27·0	1·3
1/54	—	—	—	25·9	25·1	0·8	—	—	—
1/54	—	—	—	25·4	24·8	0·6	—	—	—
2/54A	—	—	—	26·1	25·3	0·8	—	—	—
2/54B	—	—	—	26·4	25·6	0·8	—	—	—

(l) pH

The pH of the retting liquor was determined daily throughout the life of each ret up to the end of 1956 by means of the Lovibond colorimeter. The object was to observe the uniformity of retting in the tank by measuring acidity and to find out whether pH could be used to determine the completion of retting.

Samples of liquor were taken from a number of points on the surface and similarly at various depths in the tank for several months. The variation in pH was negligible between sampling points at the same level as well as between levels. It was clear that, with the types and sizes of tank used and methods of retting employed, a single sample of retting liquor taken from just below the surface of the ret gave a sufficiently accurate determination of the pH of the liquor.

It was found that pH measurements could not be used to determine the completion of retting. The variation in values between rets using dry

ribbon of the same variety or between varieties was such that no group of values could be fixed. There was a distinct difference in the pH values between dry and green ribbon rets, the pH of the green ribbon rets falling quite frequently below pH 6·0 to pH 5·3 while, in dry ribbon rets, pH values below pH 6·0 were infrequent. The pH values obtained when partially dry ribbon was used fell between the mean values for dry and green ribbon rets. Partially dry ribbon may be defined as ribbon that has been on the drying lines for one to two days and is loaded directly into the retting tanks from the drying lines. Table XVIII records the mean pH values of routine rets conducted in 1956 by groups of varieties, as well as typical retting figures from individual rets to illustrate the variation encountered.

In spite of the variation in pH values, a clearly defined general pattern of behaviour emerges. The pH value invariably rises above that of the water added to the tank following loading on the day after retting has commenced. It then falls sharply, levels off and rises slightly a day or so before retting is completed. The latter rise may not however take place. It was quite clear that a decision to discharge a ret could not be based on a determination of pH values.

(m) Non-Volatile Acidity and Dissolved Solids

When it was thought that retting would take three weeks or longer it was suggested that periodic determinations of non-volatile acidity and dissolved solids in retting liquors might be a useful guide to the progress of the ret. Determinations were carried out before the development of the successful retting technique and the results were of no value. With retting time standardized at five to seven days, it was not considered necessary to conduct further investigations along these lines as other factors gave satisfactory guidance concerning the progress of a ret.

Trials were also conducted with both green and air-dried stems in tanks as well as in the middlewalk. The retting pattern was similar to that found in the Indian sub-continent but could not be considered for adoption in British Guiana owing to the high cost of hand stripping the fibre from the stems and then washing it. With existing wage rates in 1953 and 1954, the cost of stripping and washing was greater than the value of the dry fibre.

The butt ends of ribbon, as is the case also with stem retting, rett more slowly than the rest of the ribbon. If ribbon, particularly that which is overmature for fibre production, is retted to the point where clean butts are obtained the fibre in the rest of the ribbon will invariably be over-retted. Progressive rets were tried in which the butt ends of ribbon were retted for two to three days after which the whole ribbon was retted. The improvement in cleanliness of the whole ribbon did not justify the extra cost. Trials in which ribbon was suspended vertically in a tank, either with the butts just below the surface or with the ribbon hung over a bar at the halfway point, were not successful as, not only was retting uneven but the entanglement of the ribbon during aeration could not be tolerated.

TABLE XVIII

Year 1956	Varieties	Type of ribbon	No. of rets	*Tank* Water added pH	*Loaded* Following addition of Urea pH	After Retting Tanks Loaded							
						1st day pH	2nd day pH	3rd day pH	4th day pH	5th day pH	6th day pH	7th day pH	8th day pH
Typical ret	E.C.R.–576	Dry	1	6·7	7·1	7·3	6·5	6·7	6·9	6·7	6·7	6·9	—
,, ,,	,,	Dry	1	6·5	6·7	6·9	6·5	6·5	6·3	6·3	6·3	—	—
Mean	E.C.R.–576 and E.C.R.–586	Dry	82	6·7	7·0	6·8	6·5	6·4	6·3	6·3	6·3	6·4	6·4
Typical ret	BZ–3	Dry	1	6·4	8·6	7·2	6·5	6·5	6·5	6·6	—	—	—
,, ,,	,,	Dry	1	6·3	7·1	6·5	6·2	6·2	6·2	—	—	—	—
Mean	BZ vars. and 104	Dry	125	6·4	7·4	7·1	6·4	6·3	6·3	6·4	6·5	—	—
General Mean	All	Dry	207	6·5	7·2	7·0	6·4	6·4	6·3	6·3	6·4	6·4	6·4
Typical ret	BZ–1	Partially Dry	1	6·5	6·7	6·9	6·3	6·1	5·9	5·9	—	—	—
Mean	BZ vars. and E.C.R.–576	Partially Dry	10	6·6	6·7	6·8	6·4	6·1	6·0	6·2	—	—	—
Typical ret	BZ–2	Green	1	6·5	6·7	6·5	5·9	5·5	5·7	5·5	—	—	—
Mean	BZ vars. 104 and E.C.R.–576	Green	20	6·6	7·3	6·7	6·1	5·9	5·7	5·7	5·7	—	—

The retting technique that was developed and proved satisfactory from 1955 to 1959 is described below. A dry ribbon to liquor ratio of 1 : 125 by weight is require.. If green ribbon is to be retted, the weight of green ribbon required for any tank can be obtained by multiplying the tank's dry ribbon capacity by four. The retting tank is loaded with grids or trays constructed in such a way that the layer of ribbon which is laid on each grid is equidistant from one another in the nest or stack of grids. The ribbon is laid out full length on the grid across the width of the tank one strick deep. Ten per cent. of starter by volume from an existing ret is then pumped into the tank and at the same time water is pumped into the tank (90 per cent. by volume) from the middlewalk. Care must be taken to set in place the beams holding the grids below the surface of the retting liquor before the filling of the tank is completed. Urea at the rate of 0·86 per cent. by weight of green ribbon is broadcasted over the surface of the full tank after which the tank is aerated for five to ten minutes. The ret is aerated daily in the early morning and again in the late afternoon for one hour on each occasion. By the second morning, following loading, the retting liquor should be turbid with a distinct cream colour. As the ret proceeds the liquor will become creamy grey to greyish black in colour and, by the end of a ret, the liquor may be practically clear but with a grey tint. Three days after retting has started in the case of green ribbon, and four days in the case of dry ribbon, samples comprising a few ribbons should be taken from near the surface of the tank and hand washed. If retting is well advanced it may be necessary to take a sample of ribbon from at least three ft. below the surface. Samples should be taken thereafter daily to determine when the ret should be discharged. Too much emphasis cannot be laid on the fact that retting is an art. As the speed of retting increases, so does the time available to decide when to discharge become less. When the ret is to be discharged, the liquor level is lowered by portable pumps to the top of the first layer of fibre. This permits the holding down beams to be removed as well as the top grid. The retted ribbons are either removed from the exposed grid by women working in the tank or from the grids which have been lifted out of the tank and carried to one end of the tank. The stricks of retted ribbon are then conveyed to the washing sluice by barrow. It is important that the retted ribbon never be allowed to dry out when being discharged so as to facilitate removal from the grids and washing.

The duration of rets varied according to whether green or dry ribbon was being treated and between varieties. Dry ribbon of E.C.R.–576 took on the average 1¾ days longer to ret than dry ribbon of the BZ varieties. Dry ribbon of the BZ varieties retted on the average in five days as did green ribbon of all varieties. Tow of dry ribbon obtained from the machine comb retted in four to five days. These retting times were achieved following the evolution of a suitable retting technique and have remained constant from the end of 1954. Table XIX illustrates typical results obtained in 1955 and 1956. The pattern has not changed since then.

TABLE XIX

Year	Variety	Length of ret in days								Total No. rets	Mean retting in days	Mean retting time, excluding 4 & 5 day rets
		3	4	5	6	7	8	9	10			
1955	E.C.R.–576—Dry Ribbon . .	—	3	22	44	64	16	7	3	159	6·635	6·963
1956	E.C.R.–576 and 586—Dry Ribbon	—	—	6	12	59	5	—	—	82	6·768	6·908
1956	104 and BZ varieties—Dry Ribbon	2	19	79	24	1	—	—	—	125	5·024	—
1956	BZ–3, BZ–1 and E.C.R.–576—Partially Dry Ribbon . . .	—	—	9	1	—	—	—	—	10	5·100	—
1956	BZ varieties and E.C.R.–576—Green Ribbon. . . .	—	3	11	6	—	—	—	—	20	5·150	—

In 1955 and 1956, considerable thought was given to the design of retting tanks to be used for production purposes following the development of a successful retting system. One of the major considerations in designing a tank to be constructed in the heavy coastal clay soils of British Guiana concerned the properties of this clay, particularly its angle of repose. The degree of slope of the side walls of the original wood-lined tanks at Enterprise had given trouble because the clay behind the sheathing caved in. It was thought that reinforced concrete tanks sunk into the ground would be the best solution but the cost of such tanks with an effective water depth of 5 ft., which was regarded as optimum, would be very high in relation to the annual output of fibre. Mr. J. S. Oliver spent much time studying the problem of using concrete for retting tanks and consulted several firms in the United Kingdom. The possibilities of using reinforced concrete cast in situ, pre-fabricated concrete sections, and even circular tanks, were examined and decided against. It was finally decided to design a tank with vertical ends and sloping sides with a top width of 20 ft.; a bottom width of 10 ft.; a depth of 5 ft.; and 110 ft. long. The cubic capacity of a tank of this size is 51,400 gallons and 4,100 lb. of dry ribbon or 16,400 lb. of green ribbon are required to load it. The weight of dry ribbon required to cover the grids at the correct density in any one ret varies round 4,100 lb.; short ribbon results in a reduction in weight and very long ribbon in a slight increase.

The tank consists of a trench with sloping sides and vertical ends which is lined with hardwood. Uprights at 10 ft. centres, 5 ft. from either top edge of the tank are erected down the length of the tank to carry the superstructure. An underslung horizontal runway is mounted on the superstructure from which two chain hoists are hung on a horizontal moving carriage. This is arranged to allow the grids to be lifted out of the liquor or loaded into the tank and to be conveyed to a convenient point near to the washing machine. The uprights and superstructure extend beyond the end of the tank, opposite the end where loading and unloading of the grids takes place, to permit the grids to be stacked on edge when not in use. A catwalk runs on either side of the tank outside the uprights. The nests of grids are placed between the uprights. A concrete sump is constructed at the end of the tank opposite that used for filling and the floor of the tank, which is lined with hardwood, slopes gently to the sump (Plate XIV).

Under British Guiana conditions, it was possible to arrange for the filling of tanks with middlewalk water by gravity, provision being made to fill or top up with a pump when the level of the middlewalk prevented complete gravity filling. Starter was pumped from one tank to another by portable pumps and the tank was discharged by the same pumps. Both engine driven and electric pumps were used, the latter being more efficient and easier to use. A pump capacity of 1,000-1,200 gallons per minute was preferable for both filling and discharge.

The grids or trays were made of hardwood and were constructed to stack so that the layers of bark were equidistant from one another in the stack or nest of grids and at a distance to ensure the optimum stacking of the ribbon in the tank in relation to liquor ratio and circulation. This

was achieved by making a tray in which one pair of opposite sides was deeper than the other pair thus preventing the ribbon laid on the surface of the grid from being squeezed between the cross braces of two adjacent trays when these were placed in the stack in the tank. The ribbon was supported on evenly placed cross braces placed as far apart as practicable in relation to the length of ribbon being retted. When tow of dry ribbon was retted, the grids had to be covered with mesh wire or other suitable material to prevent the tow falling through the grids (Plate XV).

The circulation of the retting liquor in the tank was achieved by laying a 2-in. air pipe down the centre of the tank and about 4 in. from the floor of the tank. At 3 ft. intervals, 1¼-in. pipes, in which a line of holes $\frac{3}{16}$ths-in. were drilled at 6 in. centres, were fitted on either side of the 2-in. pipe and at right angles to it. There were no air vent holes in the 2-in. pipe. Compressed air at 5 lb. per sq. in. is pumped into the tank during aeration at a rate of about 2¼ cu. ft. of air per hour per lb. of dry ribbon loaded (Plates XVI, XVII).

The supply of water for retting was adequate under British Guiana conditions. Consequently, all liquor was discharged to waste at the end of a ret. Trials indicated that retting liquor could be used several times without interfering with retting providing that care was taken not to pump over sludge and that a proportion of fresh water was used to top up the ret. The repeated use of retting liquor without adding fresh water did not affect retting until the third or fourth ret at which stage the retting liquor became most turbid and retting was not satisfactory. Provided a reasonable proportion of fresh water is used to make up the liquor, old liquor can be used for retting, thus saving water.

When a retting tank 110 ft. long was used the fibre produced took seven to eight hours to wash. This meant that if an eight hour day were being worked one could not discharge a 110 ft. tank, clean it and reload it in one day; two days would be required. It was therefore decided to construct a tank 60 ft. in length with a view to discharging the tank, say in the first half of the day, and having it reloaded and a new ret begun by the end of the day. This proved to be very satisfactory, both in connection with the efficient use of labour in the rettery and on the washing floor. Moreover, the time in which retting tanks remained idle between rets was cut. For commercial operations, a duplex washing sluice would require twelve retting tanks, each 60 ft. in length, to work to optimum efficiency throughout the year. Each retting tank would hold about one ton of dry ribbon which would yield on the average about half a ton of dry fibre and two tanks would be discharged daily.

The average costs of loading and discharging 110 ft. and 60 ft. retting tanks excluding depreciation, maintenance, and the cost of electric current for operating the portable pump used to discharge liquor, are tabulated in Table XX. In this instance, starter was pumped from one tank to another with small portable petrol engine-driven pumps of 1,000-1,200 gallons per hour capacity and all tanks were filled by gravity.

Washing

When plants are retted in India the fibre is stripped off the stem by

TABLE XX

Retting Tank 60 ft. long			Retting Tank 110 ft. long		
Type of labour and no. of workers	Hours each worked	Cost $ c.	Type of labour and no. of workers	Hours each worked	Cost $ c.
Loading			Loading		
6 women	2	2 79	6 women	5	6 96
4 men	2	2 73	4 men	5	6 82
1 man	3	0 96	1 man	4	1 26
Petrol for pumping starter		0 21	Petrol for pumping starter		0 31
TOTAL		$6 69	TOTAL		$15 35
Discharging & Cleaning			Discharging & Cleaning		
2 women	3	1 39	2 women	7	3 26
4 men	3	4 10	4 men	7	9 56
1 man	2	0 63	1 man	4	1 26
TOTAL		$6 12	TOTAL		$14 08
TOTAL Loading & Discharge:		$12 81	TOTAL Loading & Discharge		$29 43

hand and is immediately washed, the operator generally standing in the water of the retting pond or stream. Washing is carried out by drawing the fibre backwards and forwards in the water to loosen adhering foreign matter and by allowing it to fan out in the water which releases enmeshed dirt. Hand-washing is more effective when carried out in a slowly-moving stream of water.

The cost of hand-washing stricks of retted ribbon in a middlewalk was prohibitive. It was found that retted ribbon could not be washed by jets of water under pressure because the fibre would not open out to release enmeshed foreign matter. Preliminary work indicated that the stricks of retted ribbon to be washed must be floated in water if washing were to be effective.

A galvanized iron lined wooden sluice 2 ft. wide and 70 ft. long was built. One end of the sluice was attached to the top of a steel water-receiving box 6 ft. high and 2 ft. wide into which water was pumped at the rate of 1,000-1,200 gallons per minute through a 6-in. diameter pipe. The water was let into the box from the bottom and overflowed into the sluice over the top. Check boards 8 in. high were placed across the sluice at 8 ft. intervals down its length. Two hooks were attached to the floor of the sluice in such a way that the water cascading over the check boards impinged on the strick of fibre where it curved round the hook. The sluice was supported on trestles with a catwalk on either side of the sluice to serve the two lines of hooks. One strick of retted ribbon was placed over each hook by women and remained in the water stream for two to three minutes, being turned once on the hook during washing to enable the tightly-packed fibre round the hook to be cleaned. Washing

PLATE XV. Loading grids with ribbon

PLATE XVI. An empty 110 ft. retting tank showing aeration pipes

[*facing page 20*

PLATE XVII. Aeration of retting tank

PLATE XVIII. Washing sluice in operation

PLATE XIX. In-take end of washing sluice showing strick moving along bar down inclined feed table

PLATE XX. Take-off end of washing sluice

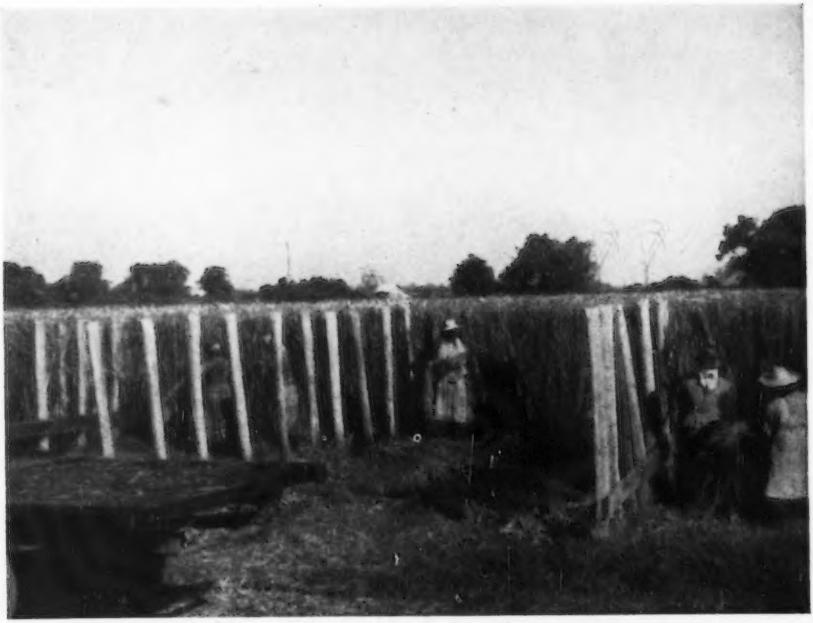


PLATE XXI. Lines for drying ribbons of fibre

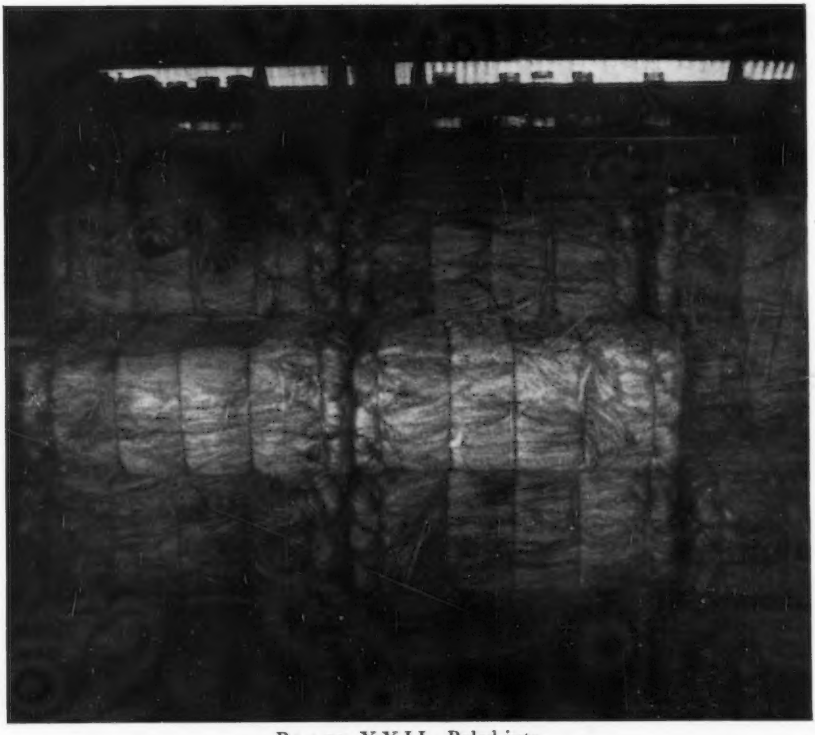


PLATE XXII. Baled jute

facing page 21

was thorough but it was considered too slow for commercial production.

Further trials indicated that if a strick was moved up the sluice against the water flow the fibre was drawn together by the speed of water flow in the section of sluice just below the cascade produced by the check boards, but fanned out and opened up in the turbulence of water just above the check boards. Such an action simulated that produced when fibre was hand-washed. Consideration was therefore given to equipping the sluice with endless ropes or chains fitted with hooks at suitable intervals which would carry a strick up the sluice against the water flow. It was found impossible to devise a simple means of drawing a strick over the top of the check board and the problem was got over by fitting small trap doors in the check boards opening up stream. The trap doors closed automatically after the strick had passed through the check board. It was found that washing was greatly improved both in speed and quality because the strick was rubbed as it passed through the trap door; moreover, the turbulence above the check boards opened up the strick more widely when the strick entered the area of turbulence from the bottom instead of being drawn over the top of the area. The difficulties encountered consisted of keeping the rope straight, preventing the hooks from fouling the check boards and keeping at work the automatic system of closing the trap doors which were often jammed open by debris.

The principles of effective mechanical washing were established in this experimental sluice, namely the need to subject a strick of retted ribbon to a series of types of water flow which cause the ribbons of fibre to be alternately opened out and drawn together and to be rubbed together in a stream of water when in the closed position.

A machine was therefore designed to wash fibre that had been taken out of a retting tank, pond, stream or river in which retting had taken place. This fibre-washing sluice is the subject of a United Kingdom patent application No. 196/59 filed by the National Research Development Corporation of London to whom application should be made if particulars are required.

The fibre-washing sluice consists of a series of specially-shaped boxes connected by pipes. The sluice is set on an incline and water is introduced at the high end and gravitates to the bottom. Stricks of retted ribbon are attached to a conveyor at the lower end of the sluice and are drawn upwards, against the flow of water, to the top of the sluice where they are removed (Plate XVIII).

The purpose of the design and slope of the sluice is to produce a turbulence of water at the lower end of each box which opens out the fibres in the strick and releases enmeshed dirt; to cause the stream of water to fan gradually outwards from the lower end of each pipe without undue turbulence; thus collecting the strick into a solid mass of parallel fibres before it enters the pipe; and to cause a friction or scrubbing action between the water and the fibre down the length of the fibre as the strick is drawn through the pipes connecting the boxes.

The water flows into the sluice at a point which may be anywhere in the top box, from a receiving tank which is fitted with baffles. The pump

capacity should be such that it allows a small proportion of the flow to overflow the top edge of the sluice, impinging on the fibre at the point where it is removed from the conveyor. The flow is used to wash the part of the fibre that is held in the grips of the conveyor during the passage of the strick through the sluice. 1,000-1,200 gallons per minute are required for a duplex sluice. The washing water can be collected, filtered and re-used for washing if required.

The conveyor consists of a stationary bar of hardwood fixed to the floor of the sluice and to the inclined feed table which is attached to the lower end of the sluice and a chain to which is attached a series of grips fitted with pins at suitable intervals.

The chain is mounted on pulleys arranged to cause the chain to move along the top of the stationary bar and engage the pins of the grips on either side of the bar. In this way, the grips slide along the bar from the bottom to the top of the sluice against the flow of water. The chain requires under load 4-5 b.h.p. The stricks of retted ribbon to be washed are laid across the bar on the feed table and are picked up by the pins of the grips and moved along against the flow of water (Plate XIX). They are removed by hand at the upper end of the sluice when washing has been completed (Plate XX).

The capacity of a duplex fibre washing sluice, each with one conveyor chain, the fibre being removed by hand after washing, varies between 250 and 300 lb. of dry fibre per hour, depending on the length of stricks being washed. The fitting of a mechanically-assisted take-off would raise the output per hour at least 50 per cent. but would in turn be limited by the speed of manual feeding which could not be dispensed with. Although a mechanical take-off was designed, it was never tested because it was found that a duplex fibre-washing sluice with hand take-off matched the 60 ft. and 110 ft. long standard retting tanks in that washing was done in half a working day in the former and in a full working day in the latter.

The average costs of washing retted ribbon from 60 ft. and 110 ft. retting tanks are recorded in Table XXI excluding depreciation and maintenance charges. The water pump and sluice conveyor chain were operated by diesel engines of 18 and 5 b.h.p. respectively.

TABLE XXI

Washing fibre from 60 ft. retting tanks			Washing fibre from 110 ft. retting tanks		
No. of workers & type of labour	No. of hours each worked	Cost $ c.	No. of workers & type of labour	No. of hours each worked	Cost $ c.
2 men	4	2 52	2 men	8	5 04
3 women	4	2 79	3 women	8	5 58
Pumping water			Pumping water		
3 gal. diesel oil		1 04	6 gal. diesel oil		2 09
Driving conveyor			Driving conveyor		
1 gal. diesel oil		0 35	1¼ gal. diesel oil		0 44
TOTAL		$6 70	TOTAL		$13 15

Drying

The layout and construction of the drying lines used for drying ribbon and fibre has been described previously under harvesting. The same lines were used to dry fibre (Plate XXI). The linear footage of drying line per ribboner previously quoted provides for the drying of fibre discharged from rets during harvest. This assumes that retting capacity is designed to operate continuously throughout the year, being geared to the production of ribbon by the number of ribboners in operation.

In five-and-a-half years of retting, the occasions when fibre could not be dried satisfactorily on the lines were few and far between provided that the normal drying time of 24 hours was extended for a further 24-48 hours. Even in the wet seasons, it was seldom that fibre remained on the lines for more than 48 hours. In sunny weather fibre hung on the lines one day was removed to store on the following afternoon. It was never found necessary to consider using expensive artificial fibre driers. No evidence was obtained that fibre was weakened by prolonging drying on the lines for 48 or 72 hours in wet weather.

Average costs of transporting washed fibre to the drying lines hanging it thereon, removing it and stacking the fibre in bonds are recorded in Table XXII for fibre discharged from 60 ft. and 110 ft. retting tanks excluding depreciation and maintenance. The same barrows used for handling ribbon were used for fibre.

TABLE XXII

60 ft. retting tanks		110 ft. retting tanks	
Transporting to and hanging on drying Lines:			
1 man for 4 hours	$1.47	1 man for 8 hours	$2.94
4 women for 4 hours each	$3.72	4 women for 8 hours each	$7.44
TOTAL	$5.19	TOTAL	$10.38
Taking fibre from drying lines:		*Transporting and stacking in bond:*	
TOTAL	$1.86	TOTAL	$2.32
GRAND TOTAL	$7.05	GRAND TOTAL	$12.70

Storage

Fibre from the drying lines was received in store in the form of stricks which may or may not be tied into bundles to facilitate handling. It was found desirable to leave fibre in store to cure for at least a month before preparing it for sale. Storage took place away from direct sunlight which discolours and weakens the fibre if exposure to such light lasts several weeks. Storage bonds found to be satisfactory for the storage of ribbon and fibre were Arcon 3-pin and tropical roof prefabricated steel structures with maximum roof extensions, they were set on a continuous reinforced concrete foundation required by the fact that the buildings were erected on heavy clay soils. Galvanized or aluminium corrugated roofing was more satisfactory than corrugated fibrocement roofing. Although both fibre and ribbon can be stored satisfactorily on

bamboo or other dunnage covering tamped clay floors that are kept dry, it is more satisfactory to have the floors of the storage bonds concreted and vapour sealed with a $\frac{3}{4}$ in. surface seal of Flintcoat-cement mixture. The need for dunnage is thereby avoided and both ribbon and fibre can be stored satisfactorily if adequate provision is made to prevent the floor being wetted by blowing rain or other causes. A wall had to be constructed just inside the eaves to within 1 ft. of the roof to prevent blowing rain entering the store and to reduce light, as well as to wall off the ends of the buildings. Corrugated galvanized iron on a wooden frame is cheap and suitable for these purposes. In the section of the buildings used for sorting, grading and baling, perspex or clear fibre glass roofing sheets may be let into the roof at suitable intervals to provide additional light. Under British Guiana conditions, the 3-pin Arcon structure was cheaper per sq. ft. than either the Arcon tropical roof or bonds constructed with locally produced hardwood. It should be borne in mind that hurricanes or cyclones do not affect British Guiana, and wind velocities of over 40 knots seldom occur.

Dry ribbon can be stored for more than two years without deterioration in the fibre so long as the ribbon does not become wet during storage and there is no insect or fungal attack. Fibre can be similarly stored save that the sides of bales which are on the outside of the stacks and therefore more exposed to light will become discoloured. Fibre produced from the jute varieties grown appeared to improve in condition if stored in the form of bales for four to six months before being sold.

Preparation of Fibre for Market

The quality of fibre varies both between rets and within rets even when the same variety of jute is being retted. Consequently, all fibre produced, even that from a single ret, has to be sorted, finished and graded to procure the highest possible financial return. The care and attention devoted to this preparation will decide whether a reasonable market can be found for the product. Offers for any single quality of fibre will be determined by the lowest quality of fibre found in the bales when sampled. Further lack of uniformity in quality in any grade will adversely affect its market value and prospects.

The combination of factors affecting quality of fibre and the interaction of these factors with each other is complex. The buyers of jute spend a lifetime in this work. The judging of quality in jute is, in fact, an art acquired by long practical experience. Fibre strength and other characteristics can be measured in laboratories and such determinations are of inestimable value when one is working on retting, variety and other problems but jute is purchased by the trade without such aids.

As a result of experience gained in preparing and grading fibre produced in British Guiana which was subsequently minutely examined in Dundee to enable mistakes to be corrected, the following major points must be constantly borne in mind by a producer who aims at selling his fibre to best advantage in the jute fibre market:

(1) In any one bale of fibre the colour of the fibre must be uniform. One must avoid mixing a white fibre with a cream fibre or with a silver-grey fibre.

(2) Fibre strength should be uniform in the bale. If only a few beets of fibre are weaker than the remainder, the price offered will be based on the value of the weaker fibre and, if too weak owing to being badly overretted, the bale might be unsaleable. Fibre strength can be judged by the gloss and lustre of the fibre, high gloss and lustre indicating good strength. Strength can be quickly tested by trying to snap a strand of fibre in the hands.

(3) It is most important that all fibre should be uniformly free from shive, particularly shive adhering to the butt ends of the ribbon. A certain amount of 'papery' shive found at the crop end of ribbon can be allowed but this should be hackled out if at all possible. The tow produced when 'papery' shive is hackled out is saleable at reasonably remunerative prices. It is also essential that the fibre within any one grade be uniform as to the degree of cleanliness of the fibre in the bales. If a particular grade contains specky fibre or fibre with a proportion of root, then the same degree of speckiness or running root should occur in all bales of that grade in all years if confidence in the constancy of grading is to be built up amongst the buyers. Extreme care is necessary to make certain that no bits of metal, stones or similar foreign matter are included in the bales.

(4) Coarse fibre should never be baled with fine fibre. The fineness or otherwise of fibre depends primarily on variety. It was observed that the degree of fineness of fibre within a variety appeared to vary within reasonably narrow limits, depending on the age of plant when harvested for fibre. Thinnings of any variety invariably produced a fibre that was finer than the average for the variety as judged by eye, while overmaturity gave a coarser fibre than that normally obtained from plants harvested at optimum maturity. This characteristic was more marked with *capsularis* than with *olitorius* jutes. This does not mean that, by harvesting a coarse variety early, a fibre equal in fineness to that of a variety which normally produces a fine fibre will be obtained. Fibre produced from the variety 104 and BZ–1 should never be baled with fibre produced from BZ–2, 3 or 4. The latter three varieties can, however, be baled together. Similarly E.C.R.–576 and BZ–5 can be baled together.

(5) It was found desirable to market separately *capsularis* and *olitorius* jutes.

(6) It is undesirable to bale short beets of fibre with long beets of fibre of the same grade. A mixture of beets results in uneven packing of the bale as well as a slight reduction in price. Short jute of similar grade to normal length jute will realize a reduced price of £5-£8 per ton.

(7) The number of grades of fibre put on the market by a new producer should be reduced to the minimum conducive to obtaining

as great a price as possible for his product. Similarly, reject grades should be as few as possible. On no account should badly over-retted fibre be included even in reject grades; such fibre can be retained for rope making for local sale or for production of bale ropes.

(a) Sorting and grading

The equipment used in these operations comprised three or four movable hackling tables with inclined tops, two knives set on the top of frames, and grids similar to those used in retting tanks on which the bundles of fibre were stacked before grading and on which the beets of fibre were stacked by grades before baling.

The hackle tables had two types of hackle pins attached to their highest edge, the table surface falling away from behind the hackle pins as seen from the hackling position. The tables were made of heavy timber to give weight and had a surface area of about 3 ft. × 2 ft. and a height of 2 to 2½ ft. at the tallest edge, giving a comfortable working position. Each table could accommodate two or three sorters. Small tables were preferred as they gave flexibility in arranging the sorters around the grading floor. The hackle pins used consisted of a set of metal pins fairly widely spaced, two to four rows deep as well as a single row of hardwood pins made from 2-in. × 1-in. Greenheart shaped to a point. Preliminary hackling or combing of both the butt and crop ends of stricks was done on the wooden pins and the strick was finished on the metal pins. The knives were made of thin section knife steel, rectangular in shape with the cutting edge along one of the long sides. These were clamped into the top of a movable frame, the cutting edge extending at least 6 in. above the top of the stand. A strick of jute was gripped by the operator on either side of the point of cutting and run up and down the cutting edge of the knife. The knives were mainly used to cut off the butt end of the stricks to improve strick quality, the butt ends or cuttings being baled separately. Roots should never be cut shorter than 6 in. One knife to two hackling tables was adequate.

Sorting was carried out by women under the immediate supervision of a foreman grader, assisted by one or two male or female graders. No difficulty was experienced in training intelligent labour for this work. Bundles of fibre in strick form were placed alongside the hackling tables and opened. The sorters opened out a strick of fibre, looked at it and decided whether it needed hackling or not. If not, it was at once handed to a grader. If hackling were required, the end of the strick to be hackled in order to straighten out the fibre and/or to remove adhering shive was thrown over the wooden hackle pins on to the table and pulled through the pins. This might be repeated several times, after which the fibre might be hackled on the metal pins. Alternatively, it might not be necessary to use the wooden pins, only the metal pins being required. Once the strick was clean of shive and the fibres lay parallel to one another, the root might be cut off if required. The root or butt ends so obtained were sold as cuttings. The finished strick was then handed to the grader.

During handling and hackling, a lot of small pieces of epidermal

tissue that might be adhering loosely to the ribbons of fibre fall off and form dust. Fibre always looks and is cleaner following this operation. The tow produced is saleable directly as 'Hubby Jubby' provided it does not contain more than 20 per cent. shive. Shive in such amounts is not obtained if the crop is harvested at optimum maturity and, if not so harvested, providing the ribbon is cleaned of shive on the drying lines or by the machine comb.

On receiving a strick of fibre from the sorter, the grader throws this out, butt end first, on to the floor, holding the crop end in his hand. Good sidelight is required for this work and was obtained by opening wide doors on the side of the building facing the grader. The fibre in the strick can be appraised at a glance for colour, gloss, lustre, cleanliness, presence or absence of root, speckiness, freedom from shive, etc., and is placed in the appropriate pile of fibre on the grading floor in the required grade. When the pile of fibre has grown large enough to make a beet, the beet is stricked and placed into storage bays in grades to await baling. This may or may not be carried out at the same time as sorting and grading is undertaken. A beet of fibre can be defined as a collection of stricks which can easily be handled by an operator using both hands, while a strick of fibre or ribbon can be handled easily with one hand. The mean weight of beets in the 1958 fibre shipment was 2·71 lb. per beet with a range of 2·50 to 3·12 lb. per beet. Sorting and grading can be considerably facilitated if the operators taking the fibre off the drying lines make up stricks of roughly the same grade as they do so.

Following the two first shipments of fibre, three grades of fibre were determined, one grade of rejections, one of cuttings and one of 'Hubby Jubby'. The fibre grades used can be briefly described as follows:

D2 — Completely clean fibre of good length with high gloss and lustre, underretted rather than overretted. A little root can be permitted in this grade if other factors are excellent.

D3 — Completely clean fibre of good length that has been slightly overretted, with good gloss and lustre, or fibre with a few inches of root but otherwise of good quality, or short fibre completely clean with high gloss and lustre.

D4 — Fibre of good length with medium to good gloss and lustre with some root and, possibly, specky or short fibre with a little root but otherwise of good quality.

Rejections — All other fibre that is not badly overretted which possesses substantial proportions of root, running root, very specky and generally dirty in appearance, caused in the main by adhering epidermal tissue.

Cuttings — All butt or root ends of retted ribbon free of shive that are cut off during sorting and grading.

'Hubby Jubby' — The tow produced when fibre is hackled. It often contains substantial proportions of 'papery' shive which is left in the crop ends of ribbons by the ribboner. The proportion of 'papery' shive in 'Hubby Jubby' is

estimated as being seldom higher than 10-15 per cent. by weight of bales and is often much less.

The average labour costs of the operations described, once the technique was fully developed, was $25.29 per acre for sorting and hackling while the cost of selecting and grading was $4.46 per acre.

Preliminary trials were carried out with a view to mechanizing as far as possible the sorting, hackling, cutting and selecting of stricks of jute fibre. Owing to the liquidation of the Company, it was not found possible to build and test the prototype machine which has been designed. A description of the machine and its method of operation is recorded below as it completes the mechanical processes necessary in any scheme for the mechanized production of jute or similar stem fibres where labour is relatively expensive.

As already described, stricks of jute fibre need to be handled to remove dust and speck. This is achieved in this machine by blowing the strick of fibre with a current of air; the combing or hackling of the crop ends of the stricks to remove 'papery' shive and straighten out entangled fibre; the possible cutting off of a section of the butt ends of the stricks to remove root; and, finally, the segregation of the stricks of fibre into grades. The machine that has been designed by Mr. J. S. Oliver enables two operators to carry out any or all of the above mentioned operations as they deem them necessary, as well as to control the speed at which the operators work.

The stricks of fibre are fed on to a conveyor chain and bar similar to that already described for the machine comb. The crop end of the strick is impaled on a comb or series of combs if required. As the conveyor moves the strick forward, the crop end of the strick is drawn through the comb to remove 'papery' shive and dirt and to straighten out entangled fibre. The strick then passes over covered-in 'A' frames which are slotted, through which a blast of air, induced by a fan, is channelled outwards. This has the effect of blowing out each end of the strick to a nearly horizontal position during which dust, dirt and speck are blown off. The selector then removes the strick from the conveyor and, if necessary, throws the butt end of the strick on to a cutting belt in such a way that the revolving knife will cut the root off at the selected point. The root or butt ends are carried away to a suitable container and the selector places the strick in a given position on a bar according to the selected grade. When sufficient stricks of any one grade have been built up on the bar, they can be removed by another operator to be formed into beets and stored before baling.

(b) Baling

Jute fibre is normally exported in 'pucca' bales of 400 lb. having a density of 60-65 cu. ft. to the ton. For the home market, and, at times for export, jute is packed in 'kutcha' bales which are about half as dense as 'pucca' bales. Modern 'pucca' bale presses are hydraulically operated and vary from double box presses costing about £7,000 to revolving box presses with a high output costing around £25,000.

Presses of this type and cost appeared to be unnecessary for an experimental project. In 1953, possible alternatives were investigated in the United Kingdom by Mr. J. S. Oliver on behalf of the company. A mechanical press with two boxes was ordered from Messrs. Shirtcliff Bros. of the United Kingdom. This was designed to make a 'kutcha' bale 48 in. × 20 ins. × 24 in. weighing 200 lb. per bale at a cost of £635 ex factory. The press was designed to be operated either by hand or by a 5 b.h.p. unit with automatic safety cut-out to prevent overwinding. The press was erected in 1954 and gave every satisfaction whether hand operated or by electric motor. It was expected that the bales would expand vertically 3 to 6 in. after tying and this occurred. The 'kutcha' bales finally produced ready for shipment had the following dimensions: 47 in. × 19 in. × 29 in. with a cubic capacity of 15 cu. ft. Bale weights steadily increased as loading techniques were improved to the point where it could be stated that this press would deliver bales of fibre averaging 400 lb. per bale. This gives a bale density of 84 cu. ft. per ton for shipping purposes. The improvement in bale densities as time went by is demonstrated in Table XXIII. It will be noted that it is not possible to bale tow to the same density as fibre or cuttings (Plate XXII).

TABLE XXIII

Type of fibre / Year	Mean bale weights in lb.			
	1955	1956	1957	1958
Fibre of Grades D2–D4 and rejections	300	381	390	410
Cuttings	—	—	364	428
'Hubby Jubby'	150	247	269	307

Beets of fibre were loaded with the point of twist of the beet at either end of the box. To obtain even packing and a dense bale, beets are loaded with their heads at either end of the box alternatively. The loader stands in the box as he loads and consolidates the fibre with his feet. The labourer feeding the loader joins him for a short while when the box is half loaded to increase consolidation and again when the box is nearly full. By this means and using fibre free from shive, bales weighing 400 lb. can be produced. As the amount of shive in the fibre increases, so does the weight of the bale become less.

Bales were tied with round wire in four places and the appropriate bale mark, stencilled on hessian, was inserted under and held by the two centre ties. Two tightening levers for the wire were used and proved satisfactory. It was decided to use steel ribbon strapping instead of round wire to reduce time spent in replacing wire ties which broke occasionally on the release of pressure in the press or during handling of the bales. Moreover, by using strapping there was less likelihood of a piece of wire getting lost in the fibre when opened for processing by the spinner, with resultant risk of fire or damage to machinery. The cheaper round wire continued to be used for baling dry ribbon.

The buyers continued to urge the need to tie bales with locally-made rope using waste or poor-quality jute fibre. Tests were carried out on a

semi-mechanized rope twisting machine developed by Mr. J. S. Oliver who succeeded quite easily in training four female labourers to make a suitable jute rope from poor quality fibre. These ropes were successfully used for tying down tractor loads of green ribbon during transport and would have been quite suitable for tying bales of jute if a standard jute press had been available. It was decided not to modify the existing bale press to enable rope to be used because it was very doubtful if the same density of bale could have been achieved with rope as was achieved with wire or strapping. It was proved that a suitable rope could be made by trained local labour which would be suitable for tying bales of fibre.

The output of the press varied but with a team of four or five men and a foreman who lent a hand as required, four or five bales per hour could be made using two boxes. The average cost per acre for baling fibre was $3.84. Baling should be carried out as far as possible in humid weather to avoid any criticism that the fibre was too dry when baled.

Yield of Fibre

Since the start of large-scale experiments in 1952, there has been the problem of obtaining even crop stands, not only throughout a bed but within fields. At Enterprise this problem arose as a result of one or more of the factors already described, affecting the establishment and subsequent growth of the crop. The major factors were (a) wet weather which adversely affected land preparation for the autumn crop, (b) weeds and (c) a subsoil effect along the interbed drains which extended 1 to 2 ft. into the bed. The result was that yields per acre of ribbon could not be calculated on the basis of the total acreage planted or harvested as the figures obtained would have been misleading. As a result, sampling was resorted to in order to determine potential yields and the range of such yields from crops of various heights that could be ribboned. Crops below 6 ft. in height were regarded as unribbonable. Yield determinations were also made more difficult by the fact that the ribboners used were being constantly improved up to 1956. Moreover, all dry ribbon weights were complicated by the admixture of varying proportions of shive, unless the crop was ribboned by an upstriker ribboner at optimum maturity for fibre production. Crop yields at the Central Agricultural Station were found to be disastrously low mainly because of soil toxicity factors and, to a lesser extent, damage by mites.

The following average ratios of green plant to ribbon have been worked out and checked over the years and have been used to determine yields. In all cases clean ribbon is referred to. The ratio of green plant to green ribbon is 2 : 1, that of green ribbon to dry ribbon is 4 : 1 and that of green plant to dry ribbon is 8 : 1, where the plant is cut at normal mowing height above the ground of 2 to 6 in. The ratio of dry ribbon to fibre is 2 : 1.

In the 1952 autumn crop, the yield of the variety E.C.R.–586 was 16 tons of green plant per acre which should give two tons per acre of dry ribbon and one ton per acre of fibre. In one field, this variety yielded 14·3 tons of green plant per acre and the weight of dry ribbon obtained for storage was 2·3 tons. The ribboner used was the Mokwa downstriker

which left a considerable amount of shive adhering to the ribbon; hence the apparent enhanced yield of dry ribbon.

In the 1953 autumn crop, samples taken from average crop in the fields being ribboned gave yields varying from 1,059 to 1,370 lb. of fibre per acre. In the 1954 autumn crop, 38 samples from the best field of jute of some 10 acres in area gave a range of yields from 782 lb. to 2,509 lb. of fibre per acre, indicating variation in growth and stand within the field. The highest bed yield was 1,908 lb. of fibre per acre while the average yield over the 53·9 acres harvested, of good, bad and indifferent crop was 26·4 tons of clean dry ribbon equivalent to 13·2 tons of fibre or a yield of 549 lb. of fibre per acre. In the 1955 autumn crop, sample yields varied from 560 lb. to 1,680 lb. of fibre per acre.

At the spring crop harvesting in March, 1956, sample yields of crop planted in November, 1955, of 806 lb. to 1,221 lb. of fibre per acre were recorded with a mean yield of 1,019 lb. of fibre per acre. It was concluded that, provided the spring crop varieties were sown in November, a yield of 1,120 lb. of fibre per acre could be expected. If plantings were delayed into December then yields would be reduced to about 680 lb. per acre, if growing conditions were good.

In the 1956 autumn crop, yields were again very variable from 322 lb. to 1,219 lb. of fibre per acre. No yield data was procured in 1957 at the Central Agricultural Station owing to the virtual failure of the crop. Eleven and a half tons of dry ribbon, obtained from patches of crop scattered over the fields and varying in height from 5 to 8 ft., were put into store.

In the 1958 autumn crop, yields were again disastrous owing to soil toxicity factors causing the crop that grew to be short. Of 87·8 acres harvested all, save 8·9 acres, only reached a height of 5 to 8 ft. This is reflected in yields which varied from 186 lb. to 895 lb. of fibre per acre with a mean yield of 486 lb. of fibre per acre.

Yield of fibre depends on the height of the crop, other things being equal. Moreover, the increase in yield generally rises more than proportionately to the increase in crop height. It is considered that any crop with an average height of less than 6 ft. is not worth ribboning. A crop, 7 to 9 ft. high, will yield a poor crop of probably half a ton or slightly less of fibre per acre while a 9 to 11 ft. crop could be regarded as average with a yield of two-thirds to threequarters of a ton of fibre per acre. A good crop would reach a height of 11 to 13 ft. and should yield threequarters to one ton of fibre per acre. The varieties E.C.R.–576, BZ–5 and BZ–4 have demonstrated that they are able to produce all three classes of crops, while the varieties BZ–1, BZ–2 and BZ–3 would probably be confined to the first two classes.

Another major factor in procuring high fibre yields is the uniformity and evenness of the crop stand and subsequent growth. It is essential that all steps are taken to prevent a check in crop growth once germination has been completed as, once checked either because of weed competition, waterlogging or drought, the crop never seems to recover its former growth rate.

Quality of Fibre

At the beginning of these trials none of the personnel had more than a very rudimentary idea of the factors determining quality of fibre or how to present it for sale. The fact that when the third and fourth shipments of fibre were examined in Dundee in 1958 it was found to have been graded and generally presented for sale in a satisfactory manner, is adequate testimony of the training given to the personnel of the Company by Messrs. Niven, Oliver, Stevenson, Urquhart and the British Jute Trade Research Association.

The first shipment of fibre in 1955 comprised 152 bales of fibre, cuttings, and 'Hubby Jubby' of just over 17 tons. All fibre produced while the retting problem was being solved, as well as fibre produced subsequently, was included. In consequence, the bulk of the consignment consisted of rejections and tow. The shipment was divided into four grades of fibre D1–D4, three grades of rejections, three grades of tow and one of cuttings.

It was found that the consignment had been subdivided into too many grades, while the best of the fibre fell into the lower section of the high quality fibre grades of Pakistan jute, being graded as Crack Daisee. There was some Grade Daisee and Mill Firsts in the shipment but the tow and lower grades of rejections were waste as they contained too much shive, or were overretted, etc. and would not normally be shipped. The strength of a sample of D–2 fibre was 364 lb. which approximated to the mean strength normally expected from a Crack Tossa (one grade higher than Crack Daisee). The colour of the fibre had lightened since leaving British Guiana. This phenomenon occurred in subsequent shipments and was of importance as it enhanced the sale value of the consignment. The main criticisms of the shipment were:

(1) Too much soft or 'papery' shive in the crop end of the fibre and shive in the butt end of the fibre was not permissible.
(2) With more careful sorting and grading and provided the fibre was free of shive and not overretted, the potential of the top three grades shown was a Crack Tossa rather than a Crack Daisee.
(3) The fibre was rather dry.
(4) Overretted fibre should never be shipped.

Six and a quarter tons of fibre were shipped in January, 1956, for appraisal in Dundee comprising 38 bales of D2–D4 fibre, rejections and cuttings together with 21 bales of 'Hubby Jubby' weighing 2 tons 6 cwt. The two top grades of fibre were classified as Crack Daisee, the D–4 grade as Grade Daisee and rejections as Continental Tossa 4. The cuttings were correctly graded. Bales of short fibre were sold as Grade Daisee.

The coarse fibre obtained from the variety 104 was down-graded to Grade Daisee because of its coarseness while fibre of the variety BZ–3 was similarly down-graded because of its grey colour. The grading of this shipment was found to be greatly improved, the beet size was satisfactory as was the freedom from shive of the fibre. It was considered in Dundee that commercially acceptable and saleable fibre had been produced which had not been overretted. A reduction in the number of grades offered was desirable.

In April, 1957, 196 bales of jute weighing 30·7 tons were shipped to Dundee comprising two grades of fibre D–3 and D–4, one of rejections, 'Hubby Jubby' and cuttings. The fibre was not examined until 1958 with a view to allowing it time to condition. On examination, the fibre was considered to be inferior to that previously shipped and worth about £20 per ton less than equivalent grades in previous consignments. No specific cause could be given for this fall in quality. In consequence, a further 5 tons 12 cwt. of fibre containing the same grades was shipped in May, 1958, and examined in the presence of the writer in August, 1958. The cause of the downgrading of the shipment examined in early 1958 was found to be the admixture in the bale of coarse fibre of the variety BZ–1 with finer fibre of other varieties. Such an admixture, even when very little coarse fibre is present, results in the downgrading of the bale or group of bales that it represents to the ruling price for the coarser fibre. Once this admixture of BZ–1 fibre was removed, the top grades of the fibre were again classified as a Crack Daisee valued at £95 per ton. If the latter fibre contained a small proportion of coarse BZ–1 fibre, the value of the fibre would be £70 per ton. Although BZ–1 fibre is saleable, it will, owing to its coarseness, always command a much lower price than that for the other proven varieties of jute and therefore should not be used for fibre production if other varieties with finer fibre grow satisfactorily.

A high quality jute fibre can be produced in British Guiana for which a ready market can be found. Labour can be trained to sort and grade the fibre. There is little doubt that average and good crops of the jute varieties E.C.R.–576, BZ–2, BZ–3, BZ–4 and BZ–5 could produce a proportion of Crack Tossa and Crack Hearts. A satisfactory grading system was worked out which met market requirements.

Plans

Engineering and other drawings of the specialized machinery developed by the Company during these investigations have been handed over to the National Research Development Corporation of 1 Tilney Street, London, W.1, England. Anyone interested in using or producing a ribboner of the type developed by the Company, or in the retting tanks, the washing sluice, machine comb and the machine to clean cut and select fibre, should approach the Corporation.

Summary

Large scale trials were carried out in British Guiana over the period 1952 to 1958 into the growing and processing of jute and the production of fibre. It was found that one variety of jute from the Sudan and five selections from jute seed obtained from Brazil could be grown satisfactorily on certain soil types on the coastlands of British Guiana. The fibre obtained from certain of these varieties was of high quality and was capable of being spun into fine yarns. The cultivation, harvesting, retting, grading and baling of jute was satisfactorily mechanized by the development of specialized machinery and by the use of standard agricultural machinery, and suitable operating techniques were developed. It was not found possible to produce jute fibre at a cost to compete with fibre

from Pakistan on the United Kingdom market. In consequence the Company was wound up as there appeared to be no possibility of developing the commercial production of jute in British Guiana.

ACKNOWLEDGEMENTS

As Managing Director of the Berbice Fibre Research Company, the writer was responsible for the planning and execution of the experiments described, being assisted from February, 1953, until the Company was wound up, by Mr. S. E. D. Foster, an officer of Bookers Sugar Estates Ltd. seconded to the Company and, from August, 1956, to December, 1958, by Mr. G. D. Baxter who was employed as an agronomist by the Company. The keenness, energy and devotion to duty of Mr. Foster is gratefully acknowledged. He was associated with all aspects of the work undertaken and his ready co-operation and assistance was invaluable. Mr. Baxter also rendered valuable service and was particularly responsible for work on the problems of aluminium and iron toxicity in soils, plant breeding and the problems involved in pest and weed control.

For some years following the formation of the Company, Mr. J. S. Oliver was the Liaison Director between the Parent Company and its subsidiary. Mr. Oliver visited British Guiana annually at the time of the autumn crop harvest and assisted the staff in all ways, particularly in the design and development of specialized machinery. In the United Kingdom he was able to search out special equipment required for trial and to consult authorities on problems requiring outside assistance. His practical assistance in British Guiana and in the United Kingdom and his cheerful acceptance of any task that would relieve hard-pressed staff and further the work of the Company cannot be too highly praised. The writer in particular wishes to acknowledge with gratitude his great debt to Mr. Oliver whose wise counsel and extensive knowledge of the handling of jute fibre and its manufacture as well as the development of prototype machinery was always unreservedly placed at his disposal. A small measure of this gentleman's contribution to this work is that he contributed to every specialized machine that was developed, in some instances originating and producing the prototype drawings.

Without the co-operation and assistance of Bookers Sugar Estates Ltd. it would have been impossible to carry out these experiments. This Company not only made the land available at Rose Hall estate but made available the material resources of the estate and in particular workshop facilities. In addition the technical and buying resources of the Booker Group of Companies was made freely available and their assistance proved invaluable. The co-operation and assistance received from Sandbach Parker & Co. Ltd. in their capacity as agents for Ferguson and other firms, T. Geddes Grant Ltd., as agents for Fordson tractors and from Plant Protection Ltd. and the Demerara Foundry Ltd. is gratefully acknowledged.

The advice and assistance of the British Jute Trade Research Association is gratefully acknowledged as well as that of H. M. Flax Establishment and the Tropical Products Institute, all of the United Kingdom, and the Colonial Microbiological Research Institute in Trinidad.

Bibliography

The sources of information listed below are additional to the references given at the end of Part I of this article (Trop. Sci., **I,** *No.* 4, 285).

Choudbury, J. K. 'Manurial Experiments on Jute', *Trans. Bose Res. Inst.*, Calcutta 1944-46, **16,** 87-94.

Finlow, R. S. 'Jute', *Trop. Agriculture*, 1928, **5,** 104-6.

Ghose, R. L. M. and Sanyal, A. T. 'Technique of Field Experiments in Jute', *Agric. Res. Mem.*, 1945, No. 4, Indian Central Jute Comm., Calcutta.

Ghose, R. L. M., Rao, K. R. and Ghosh, S. 'The Genetics of (Corchorus) Jute'. *Agric. Res. Mem.*, 1947, No. 5, Indian Central Jute Comm., Calcutta.

Ghosh, S. S., Rao, K. R. and Patel, J. S. 'Anatomical Studies on Jute (Corchorus) with special reference to the Formation of Fibre', *Agric. Res. Mem.*, 1953, No. 1, Indian Central Jute Comm., Calcutta.

Gillies, A. S. 'Hints to the Jute Grower', *Indian Fmg*, 1942, **III,** No. 1.

Jacob, A. and Coyle, V. 'The Use of Fertilizers in Tropical and Sub-Tropical Agriculture'. Ernest Benn Ltd., London, 1931.

'Jute and Hard Fibres Situation'. Bureau of Agricultural Economics, United States Department of Agriculture, 1953.

Kundu, B. C. 'Possibilities of Increased Production of Jute in the Indian Union', *Indian Fmg*, 1948, **9,** 467-79.

Patel, J. S., Ghose, R. L. M. and Das Gupta, B. 'The Genetics of (Corchorus) Jute', *Agric. Res. Mem.*, 1944, No. 3, Indian Central Jute Comm., Calcutta.

Patel, J. S. and Ghosh, S. S. 'Anatomy of Retted Jute', *Agric. Res. Mem.*, 1943, No. 2, Indian Central Jute Comm., Calcutta.

Robinson, P. and Glover, J. 'The Reliability of Rainfall Within the Growing Season', *E. Afr. agric. J.*, 1954, **XIX,** No. 3, 137-39.

Sinha, A. C. 'Jute Cultivation in Bihar'. *Indian Fmg*, 1948, **9,** 413-17.

Smith, F. 'Jute Experiments in Bengal', *Agric. J. India*, 1907, **2,** 140-60.

Supreme Commander for Allied Powers, General Headquarters, 'Fertilizer Practices in Japan' (A preliminary report), Tokyo, 1947, Natural Resources Section Report No. 93.

Thomas, A. S. 'The Production of Jute in Bengal', *Emp. J. exp. Agric.*, 1942, **10,** 98-102.

Vsevolozhakya, G. K. 'Influence of Nitrogen Nutrition Upon Acceleration of Flowering and Maturation in *Hibiscus cannabinus* (Kenaph) and Jute', C.R. *Acad. Sci. U.R.S.S.*, 1946, **53,** 847-50.

The Control of Jute Pests and Diseases in British Guiana

By G. D. Baxter

Berbice Fibre Research Co. Ltd., British Guiana

Jute is an erect annual plant reaching 10 to 12 ft. in height, and grown for its high quality stem fibre. It belongs to the genus *Corchorus* of the family Tiliaceae, and the two species *C. capsularis* and *C. olitorius* have been cultivated in British Guiana. Two crops can be grown annually, with the spring crop (November to March) consisting solely of *C. capsularis*, and the autumn crop (April to August) comprised largely of *C. olitorius* but including *C. capsularis*. Both species are susceptible to attack from a limited range of pests and diseases, the damage being sustained either through decrease in yield or loss in fibre quality. Although pest attack occurs at all stages of the crop, it is more severe in the mature crop as the "wet season" tends to be restricted to the periods December-January and May-July. The seed crop remains in the field until January (autumn crop) and August (spring crop).

Pests

The following insects and mites can be regarded as being of economic importance:

Coleoptera		
Chrysomelidae		
	Myochrous armatus	Baly
	Epitrix parvula	F.
Lepidoptera		
Noctuidae		
	Anomis editrix	Guen.
	Laphygma frugiperda	S. & A.
Hemiptera		
Cercopidae		
	Clastoptera sp.	
Acarina		
Tetranychidae		
	Tetranychus bimaculatus	Harvey
Hemitarsonemidae		
	Hemitarsonemus latus	Banks

In British Guiana jute cultivation has been carried out on land laid out in 30 ft. cambered beds stretching for a distance of approximately

PLATE I. Stem damage by *Epitrix parvula*

[*facing page 36*

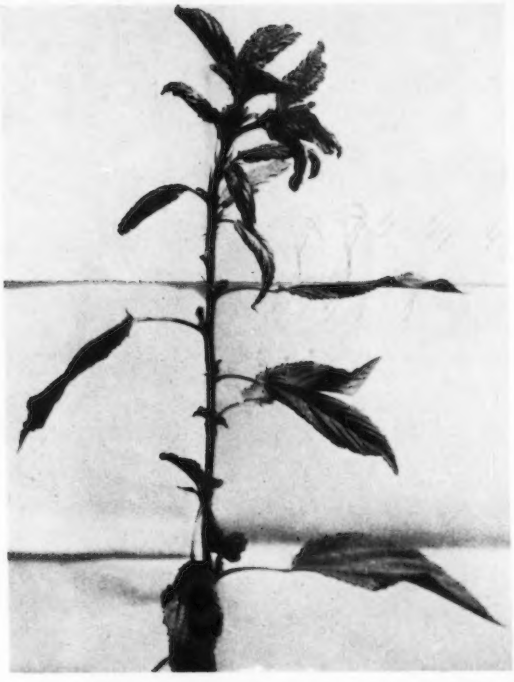


PLATE II. Leaf "crinkle" caused by *Hemitarsonemus latus*

PLATE III. Death of growing point in *C. capsularis* after a heavy attack of *Hemitarsonemus latus*

PLATE IV. Stem attacked by *Diplodia corchori*

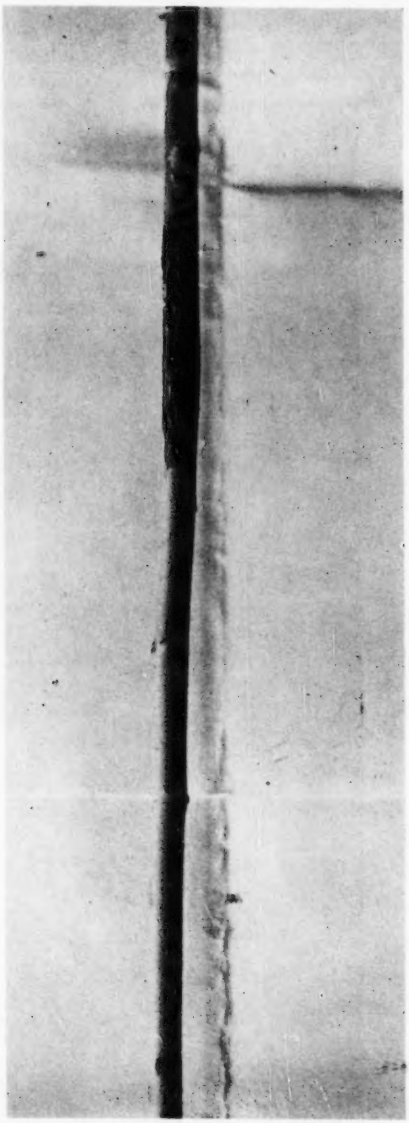


PLATE V. Stem canker caused by *Macrophomina phaseoli*

facing page 371

PLATE VI. Jute plants killed by *Macrophoma corchori*

1,100 ft. from the middle-walk (irrigation canal) to the sideline (drainage canal). The field beds are separated by a drain, 3 ft. in width, and between each field there is a cross-canal leading to the middle-walk. As the crop is sown broadcast and grows to the edge of the interbed drain, all tractor-mounted equipment or heavy power-operated sprayers are ruled out and pest control has to be carried out by operators walking either amid the crop, or along the edge of the interbed drains.

Chrysomelidae

Epitrix parvula is about $\frac{3}{16}$ in. long and a dull brownish-black in colour. *Myochrous armatus* is slightly larger and bears a distinct yellow or red pattern on each wing cover. Both the chrysomelids attack the crop at all stages of growth, sheltering in the cluster of crown leaves and feeding on the leaves and the young stem. The leaf damage is of little significance but the feeding scars on the stem (Plate I), which can be extensive, lead to improper retting and subsequent loss in fibre quality.

It is therefore imperative that the population of these insects be kept to a minimum. Complete control is prevented by rapid re-infestation from sources outside the crop. As the chrysomelids migrate readily under certain weather conditions, both the original infestation and subsequent re-infestation after control probably occur from those areas of seed-crop, sugar-cane or bush lying to windward of the crop.

The advantages of using insecticidal fogs against this type of insect were quickly realized, and work has been carried out with several models of Swingfog generator culminating with the use of the Swingfog Model SN–6. This machine is basically an exhaust-type thermal fog generator.[1] It atomises a warmed solution of the insecticide, and, by a Venturi effect in the shrouding tube around the exhaust, causes a cooling effect which results in condensation of the vaporized solvent and the formation of large numbers of minute droplets. By using a changeable outlet nozzle and atomiser it can produce a "dry fog" (drop size 0·2 to 9 microns), a "normal fog" (drop size 10 to 29 microns), or a "wet fog" (drop size 30 to 99 microns).

Normal fogging is used for chrysomelid control and this operation must be varied somewhat to suit the prevailing weather conditions. The ideal conditions, with the temperature near the ground 1°F. lower than at 6 ft. above and, with a steady wind of up to 5 m.p.h., are rarely realized, except from 5.00 a.m. to 7.00 a.m. As the work normally continues throughout the day it is to some extent hindered by ascending air currents. Fogging is favoured in British Guiana by a steady prevailing breeze of almost fixed direction which carries the fog through the crop and lessens the risk of insects moving against the direction of fogging. Each passage of the Swingfog gives a satisfactory blanketing effect over two beds (60 ft.), and three return journeys from sideline to middle-walk (12 beds) can be made without refuelling. In this way a team of three men working two Swingfogs can cover 120–160 acres per day, applying from $\frac{1}{2}$ pint to 1 pint of insecticidal fogging oil per acre on less than $\frac{1}{4}$ pint of fuel per acre.

Whilst toxaphene proved highly effective against *Epitrix parvula* it had relatively little effect on *Myochrous armatus*. The latter is however susceptible to B.H.C., and fogging, which is normally carried out once every three to four weeks, alternates between toxaphene and B.H.C., with variation to suit the infestation at any particular time.

This means of control has proved not only successful but extremely economical.

Noctuidae

The army-worm (*Laphygma frugiperda*) in British Guiana is related to the species *L. exigua*, recorded as a pest of jute in Bengal. The presence of army-worm is closely correlated with that of certain weeds:

On clay soil : *Fimbristylis miliaceae* (Cyperaceae)
On "pegasse" (tropical peat) soil : *Erechtites hieracifolia* (Compositae)
Borreria bartlingiana (Rubiaceae)

and is not normally associated with a good jute crop, i.e. a crop forming a dense weed-free stand. Infestation is variable and occurs from within the crop when the food supply provided by the weed species is exhausted. *L. frugiperda* will not attack jute unless the more palatable weed species are completely destroyed. Migration can occur but there has been no record of migration into the crop from an external source of infestation.

The full-grown larvae which can cause rapid defoliation of the crop are each up to 1½ in. long, greenish-brown in colour with a black head, dark dorsal stripe, and broad, pale, spiracular line.

Anomis editrix is related to *A. sabulifera*, the jute semi-looper of India. In British Guiana severe infestation rarely becomes apparent before the crop is 5 ft. high. The larvae is a slender green semi-looper up to 1½ in. long, with yellowish head, dark green lines down the back and a wavy dark stripe along the side. The larvae hatch from eggs on the undersurface of the leaves, and feed on the lower leaves. Later on, they repeatedly destroy the apical leaves and, unless compelled, will not feed on the older leaves. A bad attack can result in total defoliation, leaving the dried stems standing in the field.

Anomis editrix has been controlled by:

(a) Dusting with "Agrocide 3" : 0·165 lb. B.H.C. dust in 30 lb. acre.
(b) Spraying with Dieldrin : 0·187 lb. Dieldrin in 100 gal./acre.
(c) Spraying with D.D.T. : 0·75 pint D.D.T. in 100 gal./acre.

In general, dusting in British Guiana is made difficult by the high relative humidity (85 per cent. to 100 per cent.) and the hygroscopic nature of the dust bases. Experiments were carried out with several models of power-driven knapsack dusters, but the feeding mechanisms tended to clog even under the driest conditions. These machines were otherwise ideally suited to the job, as they avoided the need for walking within the crop. Dusting has therefore been carried out with small hand-operated machines, which have a minimum of moving parts and can be frequently agitated by the operator to ensure free flow of the dust. Although reliable, this method suffers from the disadvantages that one duster can only cover five acres per day when delivering 30 lb. of dust

to the acre, and, in the mature crop, the operator may suffer facial discomfort through contact with the dust.

An effective system of spraying in jute has now been perfected, comprising a unit of six or more pneumatic knapsack sprayers with a mechanically-operated charging group mounted on a trailer, and situated either at the middle-walk or side-line. Such sprayers, working at a constant pressure of 40 lb./sq. in., can discharge 2½ gal. in exactly the length of the field, the operator making the return journey with an empty can. There remains however the serious problem that the cost and speed of spraying are related to the volume required per acre. Efforts have therefore been made to devise control measures and use chemical formulations adapted to low volume application.

Unfortunately, however, low volume air-blast sprayers have proved uneconomical because of the difficulty of refilling the insecticide tank in the field, and cause operator fatigue because of their heavier weight and vibration. Moreover, they cannot be used for directing the spray downwards on to the crown leaves of the more mature plants. Attempts to achieve this have resulted in rapid overheating of the engine.

High volume spraying is therefore necessary for the efficient control of *Anomis editrix* but, as has been noted, this is both costly and slow. Thus, in spite of the fact that the residual action achieved by spraying is desirable, dusting would be recommended under dry weather conditions.

Laphygma frugiperda has been controlled by several methods depending on the method and degree of infestation, and the prevailing weather conditions. The methods were:

(a) Spraying with D.D.T. : 0·75 pint tech. D.D.T. in 50 gal./acre.
(b) Spraying with Dieldrin : 0·187 lb. Dieldrin in 50 gal./acre.
(c) Dusting with "Agrocide 3" : 0·165 lb. B.H.C. dust in 30 lb./acre.
(d) Wet fogging with D.D.T. : 0·375 lb. tech. D.D.T. in 2 pints oil/acre.
(e) Flooding followed by normal fogging with : D.D.T. : 0·281 lb. tech. D.D.T. in 1½ pints oil/acre.
B.H.C. : 0·094 lb. lindane in 1½ pints oil/acre.
(f) Baiting with Paris Green :

Spraying and dusting are the normal means of control, together with the early eradication of those weed species which enable the infestation to build up. In one case of a severe gregarious attack on young jute (2 ft.-3 ft. high), the method of flooding, followed by fogging over the flooded field, enabled a large acreage to be brought under control within 24 hours of the first signs of the outbreak. Such control could not have been achieved by any other means. Baiting has always been used as a safeguard against migration to adjacent uninfested areas, and could be used for control within the crop if the application was timed to coincide with the migration from weed host to crop.

Cercopidae

The cercopid (*Clastoptera sp.*) is about ⅛ in. in length and more or less globular in shape. The eggs are laid in shallow slits made in the stem,

normally at a branch or leaf axil. After hatching, the nymph forms the characteristic spittle mass and undergoes a series of moults. The adults which emerge from the spittle chambers for feeding damage the flowers and prevent seed setting. This pest is therefore of most significance in the seed-crop.

With the continued cultivation of jute in one area, the degree and persistency of cercopid attack has increased considerably. Originally controlled by fogging with B.H.C., it now requires dusting with "Agrocide 3" at 30 lb. per acre. Spraying with a B.H.C. formulation ("Gammalin 20") has proved unsuccessful and this has prevented cercopid control being combined with other spraying operations.

Tetranychidae

The "red mite" (*Tetranychus bimaculatus*) tends to be a secondary pest, living on those leaves which have been partially damaged through another agency such as drought or attack by *Hemitarsonemus latus*. All stages of the life cycle occur on the lower sides of the leaf, the eggs being laid mainly along the mid-rib and veins. The dark red adults measure up to 0·8 mm. in length. *T. bimaculatus* is only a serious pest if the crop is allowed to become unhealthy.

Control measures are normally not required against red mite but, in trials, it has been shown that successful control can be achieved by low-volume spraying with:

Aramite : 1·2 lb. technical/acre.
Akar 338 : 0·5 lb. technical/acre.
Basudin : 1·0 lb. technical/acre.

Hemitarsonemidae

The "yellow mite" (*Hemitarsonemus latus*) is, on the other hand, the most severe pest of jute in British Guiana, and, as yet, no effective means of control has been devised. This mite is relatively unspecific in its host relationship and, although the seed-crop is the only known source of primary infestation, there may be other unrecorded host species. The mite does not establish itself in large numbers until the crop is 5 to 6 weeks old, and serious damage rarely occurs before it is 8 to 10 weeks old and over 6 ft. high. Reports on the effect of climate vary[2, 3] and, although the most severe damage occurs in dry weather, a rapid build-up in population has been recorded (1958) in wet weather with heavy showers—conditions which had been hitherto regarded as unfavourable for the mite.

H. latus attacks only the apical leaves which are still folded or just about to be unfolded. The mites, which often escape notice because of their minute size, are white or yellowish brown, almost translucent in appearance and move rapidly on both the lamina and petiole of affected leaves.

The damage, which, depends on the density of mite population and varietal susceptibility, is of two kinds:

(a) that in which the infested leaves, although crinkled and curled over, do not drop off prematurely (Plate II). The growing point continues to produce malformed leaves, and there is a shortening of internodes with a tendency for profuse side branching.

(b) that in which the attacked leaves become bronzed, then brownish black and drop off, leaving the growing point dead, and with the appearance of having been burnt (Plate III).

Retardation of growth is severe and heavy losses in yield have been sustained. In contrast to the Indian report[4] that *olitorius* varieties suffer more damage than *capsularis*, it has been found in British Guiana that *C. capsularis* is by far the more susceptible of the two species.

Although it is known that sulphur dusted at 60 lb. per acre can give complete control of yellow mite, any method of application other than aerial dusting must be regarded as hazardous to the personnel concerned. A similar consideration applies to spraying of sulphur or lime-sulphur.

Experiments have been carried out with various types of protective clothing and the maximum that can be insisted on is: face vizor, rubber or P.V.C. apron, rubber gloves and boots. Where feasible frequent washing should replace the use of gloves and boots. When working in the close confines of a mature jute crop, *any* form of protective clothing causes discomfort and lowers the efficiency of the worker. Close fitting face masks or totally enveloping headwear as would be required for sulphur dusting or spraying are a practical impossibility.

Control measures against yellow mite do not commence until the crop is 6 ft. high and must continue until it is 6 to 12 ft. high. As the spraying or dusting must aim at a satisfactory coverage of the innermost crown leaves, it is directed downwards, and the operator is in continual and extensive contact with the chemical, even when working in the same direction as the prevailing wind. Knapsack sprayers have been used with the extension lances, angle beds and single swivel nozzles. In autumn crop 1957, a high degree of control was achieved with Aramite 2E applied at 1½ pints in 20 gal. per acre. By autumn crop 1958, the mite proved almost completely resistant to this acaricide even when applied at high volume.

At this stage extensive acaricide trials were carried out and the six most promising treatments selected from a series of preliminary trials gave the following results at high volume application (100 gal. per acre):

Treatment	*Dosage per acre*	*Average number of mites per leaf*
1. Control	—	73·6
2. Dusting sulphur	60 lb.	0·0
3. Aramite 2E	2½ pint Emulsifiable Concentrate	67·9
4. Aramite 2E + P.P. Summer Ovicide	2½ pint E.C. + 2 lb. Wettable powder	29·5
5. Phenkaptone	32 fl. oz. E.C.	73·5
6. Rogor 40	48 fl. oz. E.C.	17·5

From this and work in other countries [5, 6, 7, 8, 9, 10] it may be concluded that, in general, organo-phosphorus formulations are not effective against yellow mite and further trials would have to be confined to formulations of sulphur, nicotine or pyrethrum.

Conclusion

Under conditions of optimum growth and good husbandry, jute in British Guiana is only subject to attack from a limited number of pests, for most of which effective control measures have been devised. However, under poor growing conditions due either to unfavourable soil or weather, jute will not only be attacked severely by yellow mite which can completely stunt all varieties of *C. capsularis*, but weed growth will lead to the need for costly control measures against noctuid larvae.

Whilst the use of insecticidal fogs has provided not only a suitable, but an extremely economical means of pest control, the development of spraying and dusting technique has had to overcome difficulties imposed by the field lay-out, growth habit of the crop, and weather conditions.

Diseases

The following important diseases have been recorded:

Fungi. Deuteromycetes
Sphaeropsidales
Diplodia corchori Syd.
Macrophomina phaseoli (Maubl.) Ashby
Macrophoma corchori Saw.

The occurrence of *Diplodia corchori* has been sporadic, with generally not more than 3–5 per cent. of the plants being infected, and in only one year was a small epidemic outbreak recorded. The disease appears with the formation of a discoloured ring or band round the stem which gradually becomes brownish black and spreads up and down the stem, resulting in rapid death of the plant (Plate IV). The pycnidia are superficial, occurring in the outer layers of the cortex, and can be seen as spherical black bodies on the diseased stem. The point of primary infection is often at the base of a lateral branch.

Macrophomina phaseoli (Muabl.) Ashby is synonymous with *Macrophoma phaseoli* Maubl., *Rhizoctonia batiticola* (Taub.) Buth., and *Sclerotium batiticola* (Taub.). *Macrophoma corchori* (Saw.) is synonymous with *Sclerotium batiticola* (Taub.), except for the fact that *S. batiticola* will not form the pycnidial-stage on jute.[11] *M. corchori* was identified at first as *Rhizoctonia solani* Kühn., but later[12] shown to be morphologically indistinguishable from *S. batiticola*.

Both *Macrophomina phaseoli* and *Macrophoma corchori* occur sporadically throughout the crop, but have been recorded on up to 29·0 per cent and 30·4 per cent. of the crop respectively on clay soil.

The primary lesions of *M. phaseoli* usually occur at the nodes. The majority remain as small black areas but others increase in size to form severe lesions. These lesions may girdle the stem, but more generally extend lengthwise on the stem, splitting open the cortex to expose the fibrous layer, and forming a deep furrow where they coalesce (Plate V). In many cases they are restricted by cork formation to form a canker. Pycnidia are found in the epidermis and sclerotia in the ray cells and softer tissues of the phloem and xylem.[13] While this disease rarely kills the plant it causes economic loss through damage to the fibre layers.

Macrophoma corchori appears on the more mature plants as a reddish brown discolouration of the stem just above ground level. This area gradually darkens and spreads but the plant normally withers and dies (Plate VI) while it is restricted to a collar at the base of the stem. Small black sclerotia are formed in the stem among the fibres, and pycnidia just below the cuticle.[11]

The disease occurs sporadically but can become widespread and severe after irrigation. It is of little importance in the fibre crop as irrigation does not normally take place until the crop is well advanced, but those areas which are retained for seed production can suffer heavy loss.

Disease Control

The control measures include firstly, the elimination of all factors such as water-logging or potash deficiency which are known to encourage the diseases, and secondly, the treatment of all seed with "Agrosan" GN at the recommended rate of $5\frac{1}{2}$ oz./cwt.

References

(1) Hughes, R. D., "A Survey and Trial of the Use of Insecticidal Fog in Public Health Work", 1957.

(2) Holdaway, F. G., and Look, W. C., "Insects of the Garden Bean in Hawaii", *Proc. Hawaii ent. Soc.*, 1942, **II**, No. 2, 249-60.

(3) Vrydagh, J. M., "Etude de l'Acariose du Cotonnier Causée par *Hemitarsonemus latus* (Banks) au Congo Belge", *Inst. Etude agron., Congo Belge Sèr. sci.*, 1942, No. 28.

(4) Das, G. M., "Insects and Mite Pests of Jute", *Science and Culture*, 1948, **14**, No. 5, 186.

(5) Holdaway, F. G. *et al.*, "Entomological Problems", *Rep. Hawaii agric. Exp. Sta.*, 1941-2 (Honolulu, 1943), 111-27.

(6) Lavoipierre, M. M. J., "*Hemitarsonemus latus* (Banks) (Acarina); A Mite of Economic Importance New to South Africa". *J. ent. Soc. Sthrn. Afr.*, 1940, **3**, 116-23.

(7) Smith, F. F., Fulton, R. A., and Hall, S. A., "Toxicity of Organic Phosphates to the Two-Spotted Spider Mite and Foxglove Aphid". *J. Econ. Ent.*, 1950, **43**, No. 5, 627-32.

(8) van Marle, G. S. "The Infestation of Begonia by Mites belonging to the Genus *Tarsonemus*", *Tijdschr Pl. Ziekt*, 1944, **50**, No. 2, 25-39.

(9) "Report on Pests and Diseases of Crops in the Belgian Congo, 1940-41". *Leopoldville Inst. nat. Etude agron. Congo. Belge*, 1943, 152.

(10) "Insect Pests", *Agric. Gaz. N.S.W.*, 1941, **52**, Part 7, 363-8, Part 8, 430-34.

(11) Shaw, F. J. F., "*Macrophoma corchori*. Saw", *Mem. Dep. Agric. India*, 1924, **13**, No. 6, 193-99.

(12) Martin, W. H., "*Sclerotium bataticola*", *Phytopathology*, 1917, **7**, 308-12.

(13) Varada Rajan, B. S., and Patel, J. S., "Stem-Rot Disease of Jute", *Indian J. agric. Sci.*, 1943, **13**, Part 2, 148-56.

The Control of Insects Infesting Groundnuts after Harvest in the Gambia: II. Field Trials on the Control of the Groundnut Borer, *Caryedon gonagra* (F.)

By A. A. Green

Pest Infestation Laboratory, Agricultural Research Council

Summary

A comparison has been made in field trials of DDT and lindane dusts and dispersible powders for the protection of undecorticated groundnuts from infestation by the Groundnut borer, *Caryedon gonagra* (F.). Dusts were slightly more effective than dispersible powders and had practical advantages. Treatment of the surface of heaps of nuts with a single dose of DDT at 400 mg./sq. ft. or fortnightly doses of lindane at 20 mg./sq. ft. gave virtually complete protection against infestation during a storage period of four months. Final recommendations were for the use of 0·5 per cent. lindane dust, 1 lb./100 sq. ft. (about 40 mg. lindane/sq. ft.) to be applied to the surface of bulk-stored nuts and 6 oz./100 lb. bag (about 19 parts per million) to be mixed with nuts intended for seed.

Introduction

A study was made[1] of the behaviour and life-history of the groundnut borer, *C. gonagra* (F.), under field conditions in the Gambia, and possible methods of control were considered.

Field experiments are now described in which DDT and lindane were compared for the control of *C. gonagra* infesting undecorticated groundnuts stored in large heaps (seccos) while awaiting shipment or decortication.

Because of the limited time available for the entire investigation, most of the experimental work was planned and carried out concurrently with the survey work and little of the information reported in the previous paper on the habits and life-history of the insect became available until the insecticidal trials were in progress. The experiments were, therefore, concerned both with surface treatments and treatments within the heaps of nuts because it was not then known whether the insect could live and breed within a bulk of nuts or whether it needed to spend some part of its life at the surface.

Facilities for the trials were available only in the Bathurst district and its surroundings although heavier infestations in up-river districts would have provided better experimental conditions. The experimental sites consisted of an indoor store in Bathurst and an open site at Kanifin.

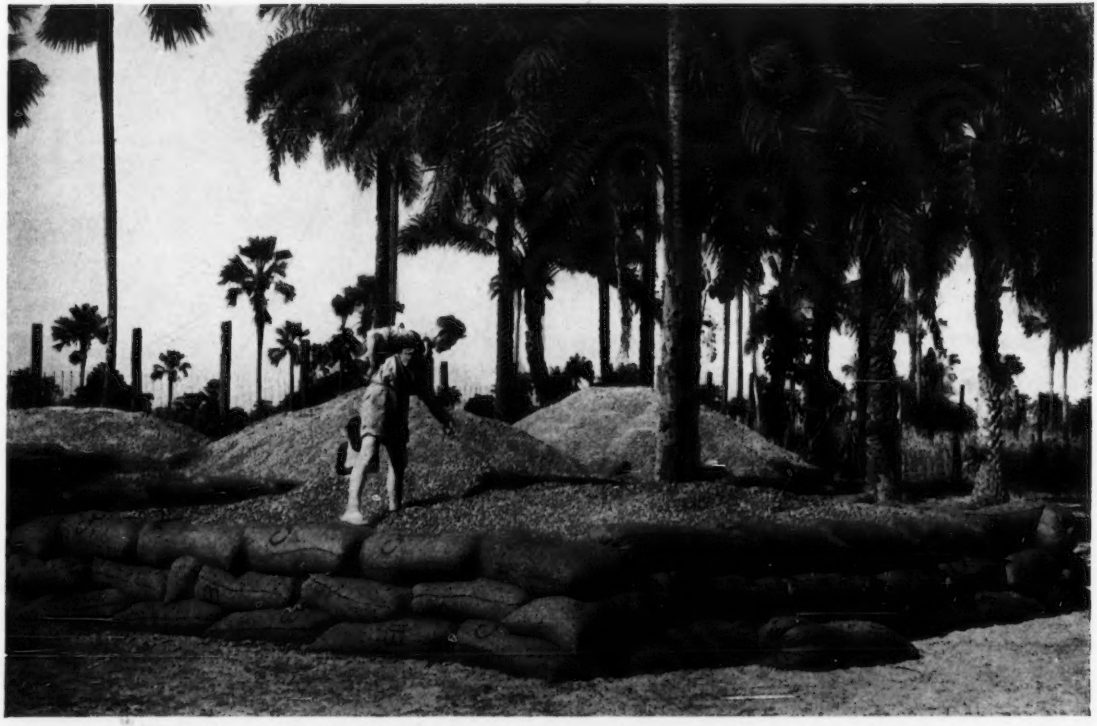


PLATE I. The application of insecticidal spray to a partly-constructed, large heap of groundnuts. Completed heaps are shown in the background

[facing page 41

facing page 151]

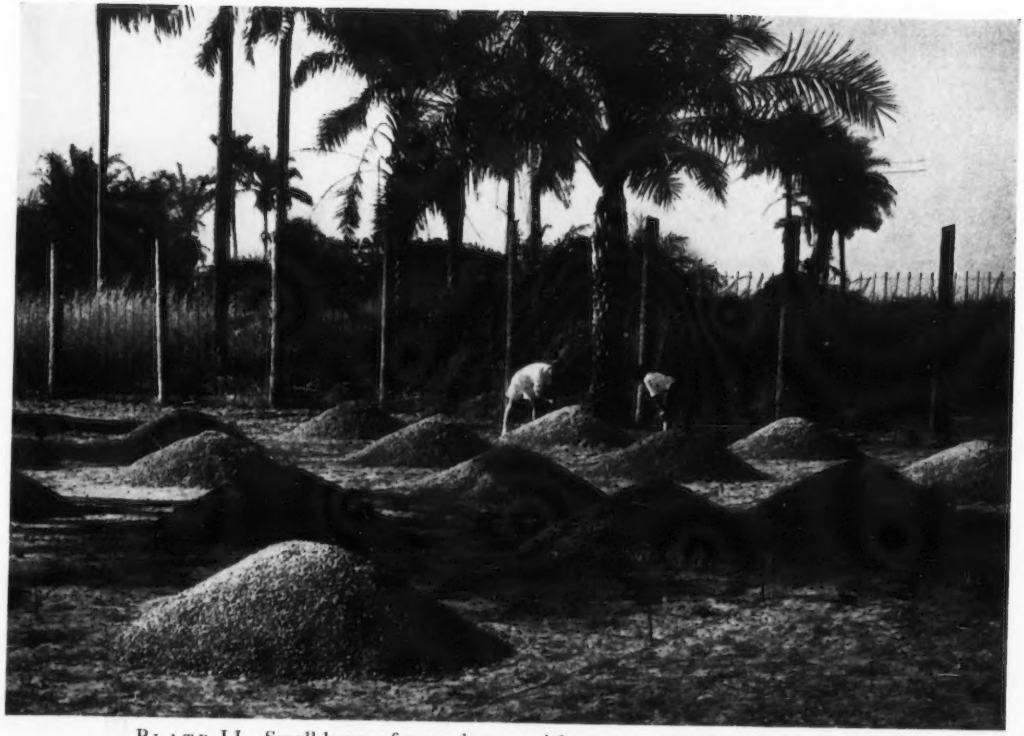


PLATE II. Small heaps of groundnuts used for comparison of surface treatments

Insecticidal Treatments

Bearing in mind the generally primitive conditions, the limited finances of the Gambian groundnut industry and the shortage of skilled labour, the following limitations were imposed on the experimental work: the insecticide was to be cheap and readily available in the sterling area, easily prepared or already prepared, of low toxicity to mammals and non-tainting when mixed with food; its application was to be simple and not to involve the use of expensive or complicated machinery. The obvious insecticides were DDT and lindane and, with the short time available for experiment and subsequent observation, it was decided to restrict formulations to dust and water-dispersible powder. All dosage rates were kept within the limits of 2·5 parts per million of lindane and 7 parts per million of DDT recommended by the Agricultural Research Council in the 'Revised Code of Practice for Colonial Territories'. The exposure period was planned to be three months but was extended to four months because infestations were slow to develop.

Bulk treatments

Admixture of an insecticide throughout the bulk of groundnuts stored in seccos would be quite impracticable under the primitive conditions prevailing in the Gambia although it was reported that some success was being achieved by this method in Sénégal.[2] Furthermore, the limited dosage rates, particularly with DDT at 7 parts per million were likely to be of low toxicity to the insects.[3] However, by applying the insecticide in layers as the heaps were built, application was relatively easy and high local concentrations of insecticide were achieved.

It was clearly desirable that the heaps should be large enough to take advantage of possible control by the diffusing vapour of lindane. The largest heaps which could be built on the sites available contained about 15 tons of nuts. Each heap was on a rectangular base, with sides built up to a height of about 2 ft. 9 in. with three layers of bagged nuts; loose nuts were tipped into the enclosed space and piled above it (Plate I). At Kanifin, nine such heaps were built outdoors on 20 ft. square bases and formed rough pyramids about 8 ft. high. At Bathurst, three heaps were built inside a store but, because of the shape of the building, were on bases measuring 20 × 25 ft. and formed mounds 5 to 6 ft. high.

After each 5 tons of nuts had been added, insecticide was applied in a layer at the rate of 2·5 parts per million or 7 parts per million for lindane and DDT respectively. The dusts were applied by means of a hand rotary duster and the sprays by a pneumatic hand-sprayer fitted with an unchokable limewashing nozzle. Details of treatments, doses, etc., are given in Table I.

Surface treatments

For surface treatments, very heavy deposits of insecticide could be used while remaining within the limits of 2·5 parts per million lindane and 7 parts per million of DDT in relation to the bulk. Furthermore, there being no question of fumigation beneath the surface, small heaps could be used provided that the dosage rates were related to bulk storage.

TABLE I

Details of bulk treatments

Site	No. of replicates per treatment	Insecticide	Formulation	Dose (active ingredient) parts per million
Kanifin, outdoors	2	DDT	5 per cent. dust	7·0
	2	Lindane	1 per cent. dust	2·5
	2	DDT	50 per cent. dispersible powder diluted to 1 per cent.	7·0
	2	Lindane	25 per cent. dispersible powder diluted to 0·1 per cent.	2·5
	1	Control	Not treated	
Bathurst, indoors	1	DDT	5 per cent. dust	7·0
	1	Lindane	1 per cent. dust	2·5
	1	Control	Not treated	

In calculating the dosage limits it was assumed that few, if any, seccos contained less than 450 tons (about 1,000,000 lb.). A secco of this size has a surface area of about 5,400 sq. ft. which allows maximum dosages of 588 mg./sq. ft. for DDT at 7 parts per million and 210 mg./sq. ft. for lindane at 2·5 parts per million. It was likely, however, that, in tropical sunlight, lindane would lose its toxicity very quickly and that repeated applications at short intervals would be required. It was therefore decided to compare a single application of lindane at 120 mg./sq. ft. and fortnightly applications at 20, 40 and 60 mg./sq. ft. with single applications of DDT at 200, 400, and 600 mg./sq. ft. The DDT and lindane dusts were applied by shaking through 15 and 18-mesh sieves respectively and the sprays by means of a pneumatic hand-sprayer fitted with an unchokable limewashing nozzle.

The small experimental heaps were conical, about 2 ft. in height and 7 ft. in diameter, and contained 400 to 450 lb. of nuts. Thirty-four heaps were built on a flat, sandy site at Kanifin (Plate II) and nine heaps in the closed store at Bathurst. There was not sufficient room in the store for untreated small heaps; control observations were therefore confined to the untreated large heaps. Details of treatments, doses, etc., are given in Table II.

Sampling and estimating techniques

To ensure that true samples of nuts could be taken from beneath the surface of the large heaps at the end of the storage period, string mesh

TABLE II

Details of surface treatments

Site	No. of replicates per treatment	Insecticide	Formulation	Dose (active ingredient) mg./sq. ft.	Frequency of dose	Purpose of Experiment
Kanifin, outdoors .	3	DDT	5 per cent. dust	200, 400 and 600 respectively	Initial dose only	To determine effective levels of dosage
	3	Lindane	1 per cent. dust	20, 40 and 60 respectively	Fortnightly	
	3	Lindane	1 per cent. dust	120	Initial dose only	To compare effect of single heavy dose with small fortnightly doses
	3	DDT	50 per cent. dispersible powder diluted to 1 per cent.	200	Initial dose only	To compare dusts and dispersible powders
	3	Lindane	25 per cent. dispersible powder diluted to 0·1 per cent.	20	Fortnightly	
	7	Control	Not treated			
Bathurst, indoors .	3	DDT	5 per cent. dust	200	Initial dose only	To compare with outdoor results
	3	Lindane	1 per cent. dust	20	Fortnightly	
	1	Control	Not treated			Large heap acting as control for all indoor tests

bags were buried in the heaps each containing about 12 to 14 lb. of nuts and having a stout cord leading to the outside of the heap. At Kanifin one string bag was buried a few inches beneath the surface on a sloping side (position 1) and one in the approximate centre of the heap (position 2). At Bathurst, three string bags were buried in each heap, one above the other in a central vertical line at 1 ft., 3 ft., and 4 ft. 6 in., from the surface (positions 3, 4, and 5 respectively). After some settling of the heap, however, and disturbance of the surface nuts by animals, the near-surface bags (position 1) were often exposed and the 1 ft.-deep (position 3) bags were about 6 in. from the surface.

At the end of 12 weeks, samples of about 1½ lb. of nuts were taken, one from each small heap and two, one from the top and one from the side, from each large heap. All samples were taken from the surface to a depth of about 2 in., sealed in polythene bags and despatched by air to the Laboratory. The sampled areas were re-treated and marked so that they would not be used for further observations.

After 16 weeks storage, a further set of samples was drawn and, in addition, all heaps were broken down and observations made on their internal condition. The buried string bags containing nuts were retrieved, immediately sewn inside thick calico bags to prevent cross-infestation, and sent back to the Laboratory.

To assess the degree of infestation, about 200 nuts (1/4 sample) were taken from each of the samples from small heaps and about 400 nuts from each of the samples from large heaps. Each nut was first inspected for adhering *Caryedon* eggs; after opening the nut, each seed was cut and examined for infestation by *Caryedon*, *Tribolium*, *Oryzaephilus*, and *Ephestia* species.

Results

The *Caryedon* infestations developed much more slowly than had seemed probable from reports of infestations in previous years and did not become heavy until March and April. This, as mentioned earlier, necessitated an extension of the storage period from three months to four months. Unfortunately, the Kanifin area proved to be one of low infestation and no heavy infestations developed even though, in February, several sacks of infested nuts were brought from Sankwia and tipped near the experimental heaps to encourage cross-infestation. At the Bathurst store, the infestation developed more as expected and, by April, had become very heavy. Infestation by other stored-product insects did not increase appreciably beyond the initially low numbers even in the control heaps.

Many of the small heaps at Kanifin became heavily infested with termites which cemented the centre nuts together and formed a hard core.

The results of the layered treatment of large heaps are summarized in Table III and those of the surface treatment of small heaps in Table IV.

TABLE III

Effect of layered treatments with DDT and lindane on infestation of large heaps by C. gonagra

Site	Formulation	Sample position	DDT 7 parts per million				Lindane 2·5 parts per million			
			Mean percentage infestation				Mean percentage infestation			
			Eggs		Damaged nuts		Eggs		Damaged nuts	
			12 weeks	16 weeks	12 weeks	16 weeks	12 weeks	16 weeks	12 weeks	16 weeks
Kanifin, outdoors	Dust	Surface top	2·8	32·5	1·2	16·8	3·2	20·5	2·6	13·0
		Surface side	5·2	—	2·6	—	3·8	—	3·1	—
		Internal position 1	—	19·8	—	18·8	—	4·8	—	2·1
		Internal position 2	—	0	—	0·1	—	0	—	0·3
	Dispersible powder	Surface top	5·1	30·8	3·6	16·5	3·9	43·3	2·5	19·3
		Suface side	2·2	—	1·3	—	8·8	—	6·9	—
		Internal position 1	—	3·9	—	2·0	—	9·5	—	5·3
		Internal position 2	—	0·3	—	0·4	—	0·5	—	0
	Control	Surface top	6·1	41·3	4·9	21·0	6·1	41·3	4·9	21·0
		Surface side	10·4	—	9·1	—	10·4	—	9·1	—
		Internal position 1	—	42·3	—	25·5	—	42·3	—	25·5
		Internal position 2	—	0	—	0·3	—	0	—	0·3
Bathurst, indoors	Dust	Surface top	1·1	27·3	1·3	11·0	3·5	8·0	2·6	2·5
		Surface side	0·8	—	0·6	—	0·7	—	0·2	—
		Internal position 3	—	0·3	—	0	—	0·3	—	0
		Internal position 4	—	0·3	—	0·3	—	0	—	0
		Internal position 5	—	0·3	—	0·3	—	0	—	0
	Control	Surface top	14·8	95·0	7·1	59·0	14·8	95·0	7·1	59·0
		Surface side	13·2	—	8·5	—	13·2	—	8·5	—
		Internal position 3	—	0	—	0·3	—	0	—	0·3
		Internal position 4	—	0·5	—	0·8	—	0·5	—	0·8
		Internal position 5	—	3·0	—	1·8	—	3·0	—	1·8

TABLE IV

Effect of surface treatments with DDT and lindane on infestation of small heaps by ***C. gonagra***

Site	Formulation	DDT					Lindane				
		Dose (active ingredient) mg./sq. ft.	Mean percentage infestation				Dose (active ingredient) mg./sq. ft.	Mean percentage infestation			
			Eggs		Damaged nuts			Eggs		Damaged nuts	
			12 weeks	16 weeks	12 weeks	16 weeks		12 weeks	16 weeks	12 weeks	16 weeks
Kanifin, outdoors	Dust	200	1·9	2·0	1·1	1·2	20 fortnightly	0·2	0·3	0·3	0·4
		400	0·1	1·0	0	0·4	40 fortnightly	0·1	0	0	0
		600	0·3	0·8	0	0·8	60 fortnightly	0·3	0	0·2	0
							120	2·3	1·4	1·3	0·9
	Dispersible powder	200	3·7	8·4	1·8	6·0	20 fortnightly	1·7	1·6	1·6	0·8
	Controls		8·0	7·7	7·1	6·3		8·0	7·7	7·1	6·3
Bathurst, indoors	Dust	200	0·5	2·6	0·3	2·8	20 fortnightly	0·2	0	0·2	0
	Controls (large heap)		14·0	95·0	7·8	59·0		14·0	95·0	7·8	59·0

Observations and Preliminary Recommendations

As reported previously[1], the infestation of the nuts contained in string bags showed clearly that *C. gonagra* lives and breeds only within a few inches of the surface of a bulk of groundnuts. Treatment of only the surface nuts is therefore required for control.

Although not markedly different in degree of effectiveness, dusts seemed slightly better than dispersible powders. Bearing in mind, therefore, that dusts had considerable practical advantages under local conditions, recommendations were restricted to the use of dusts.

DDT dust applied to the surface at 200 mg. DDT/sq. ft. gave good control but allowed the development of a small infestation and was probably a threshold level for safe dosage. Some confirmatory evidence can be adduced from the experiment on large heaps where the surface dosage was probably in the region of 85 mg./sq. ft. and relatively poor control was achieved. At 400 and 600 mg./sq. ft., control was virtually complete.

Lindane gave complete control at all the fortnightly dosage levels used, i.e. at 20 mg./sq. ft. and above. A single dose of lindane at 120 mg./sq. ft. gave almost complete control and was as effective as DDT at 200 mg./sq. ft. In the experiment on large heaps, the single dose applied to the surface, approximately 30 mg./sq. ft. gave relatively poor control outdoors but good, although not complete, control indoors. It had been expected that, exposed to the hot sunshine, single doses of lindane would remain effective for only a few days and the heaps would become heavily infested but, in view of the unexpectedly long period of protection given by these single doses of lindane, it seemed reasonable to expect that 40 mg./sq. ft. of lindane applied monthly would be satisfactory.

Choice of treatments to be recommended was, therefore, narrowed to a single dose of dust at 300 to 400 mg./sq. ft. or monthly doses of lindane at 40 mg./sq. ft. Although DDT had the advantage of requiring only a single dose, the dosage rate could not be lowered for short periods of storage. Furthermore, the frequent disturbance caused by collections and deliveries requires re-treatment of newly exposed surfaces and this, if DDT were used, could lead to serious overdosing. Comparing the costs of insecticide for a single dose of DDT at 400 mg./sq. ft. with monthly doses of lindane at 40 mg./sq. ft., it was estimated that: (1) lindane would be cheaper if the nuts were stored for one month; (2) DDT and lindane would cost about the same for two months storage; (3) DDT would be cheaper for more than two months storage. The average period of storage was expected to be about two months and it was decided therefore to use 1 per cent. lindane dust for all treatments.

Detailed recommendations were made for the control measures to be followed during the 1955-56 season which was to be a trial period. These measures included the monthly treatment of the surface of all seccos with 1 per cent. lindane dust at the rate of 1 lb./100 sq. ft. (about 40 mg. lindane/sq. ft.) and the dusting of seed nuts, before storage in bags, at the rate of 3 oz. per bag containing about 100 lb. of nuts. This was the smallest amount which could be mixed evenly with the nuts and it was thought preferable to use the available concentration, although resulting

in a lindane dosage of about 19 parts per million, rather than introduce the complication of a lower concentration specifically for seed nuts. There was, however, no toxic hazard since the nuts were not destined for use as food.

Observations on One Year's Trial

During the trial season a considerable degree of control was achieved but some practical difficulties were encountered.

Normal trade movement of nuts to and from the secco and interference by animals resulted in the frequent exposure of untreated nuts and led to the development of pockets of infestation. It was obvious that few traders would co-operate sufficiently to give special attention to newly-exposed areas and that more frequent general treatment was necessary. It was also found that, in practice, 3 oz. of dust per bag was insufficient, to obtain even admixture with seed nuts. The lindane concentration was therefore, reduced to 0·5 per cent. so that seccos could be treated fortnightly, while retaining the dosage rate of 1 lb./100 sq. ft., and seed nuts could be dusted at the rate of 6 oz. per bag.

A further difficulty encountered was in the considerable variation between various commercial dusts in their properties of adhesion to the groundnut cortex. Movement of the surface nuts resulted in poor dusts falling between the nuts and forming a layer beneath the surface. In some laboratory tests, the amount of dust adhering to groundnuts during a standard sieving process was determined and the variation for 11 commercial samples ranged from 0·14 per cent. to 0·45 per cent. of the weight of the nuts.

The colour of the dust also proved to be very important since evenness of deposit was judged visually. One product, prepared from crude china clay, was so similar in colour to the groundnuts and to local, drifting sand as to be almost undetectable after application.

It was apparent at this stage that continuous supervision by an expert would be necessary in order to administer a large-scale programme of control. Proposals were made, therefore, for the appointment of a trained Pest Control Officer.

Final Recommendations

Final recommendations based on the results of the 1954-55 experiments and modified in the light of one year's trial were as follows:

1. A Pest Control Officer should be appointed to the Department of Agriculture.
2. An insecticidal dust should be used to protect undecorticated groundnuts at all stages of storage. The dust, which should be of distinctive colour from the groundnuts, should contain 0·5 per cent. lindane and should adhere well to groundnut shell.
3. At the beginning of the groundnut harvest season, all sacks which are to be used for conveying or storing undecorticated groundnuts should, unless new, be dusted internally with 0·5 per cent. lindane. 1 oz. of dust should be used in each sack and be thoroughly distributed so as to reach the neck and the bottom corners.

4. All seccos, and other stores where groundnuts may be kept, should be thoroughly cleaned at the end of each storage season and the refuse burned immediately. Before re-use they should be treated with 0·5 per cent. lindane at the rate of 2 lb. of dust per 100 sq. ft.
5. Nuts stored in bulk should be dusted with 0·5 per cent. lindane, once every two weeks, at the rate of 1 lb. of dust per 100 sq. ft. of heap surface. Actual dates should be specified in advance by the appropriate authority so that, throughout the territory, all nuts are dusted on the same day. Additional dusting should be given when collection or delivery of nuts has exposed untreated areas.
6. When seed nuts are bagged for storage or for distribution, they should be treated with 0·5 per cent. lindane dust at the rate of 6 oz. per bag. The dust should, as far as possible, be evenly distributed throughout each bag of nuts.

These recommendations were adopted by the Gambian Government and where the measures have been conscientiously applied, excellent control has been achieved. An account of the practical applications will be given by the Pest Control Officer in a later paper in this series.

Insecticidal Contamination of Nuts

In view of the difficulty of ensuring accurate dosing with insecticide, it was important to determine the proportion of dust which, after application to the nuts in shell, could pass through the decorticating machines and cause contamination of the shelled nut. A small experiment was therefore carried out.

Method. 1 per cent. lindane dust was poured slowly into the stream of nuts as they were tipped from one bag to another. Rates of application were 3 oz. and 12 oz. per bag: three bags were used for each treatment. Each bag contained 90 to 100 lb. of nuts, so that the two rates of treatment were about 20 and 80 parts per million of gamma-BHC respectively.

Each bag of treated nuts was passed through a decorticating machine at the Denton Bridge Mill, and the shelled nuts re-bagged. A 2 lb. sample was then taken, comprising equal amounts from the top, centre and bottom of the bag. Each sample was sealed in a plastic bag and sent by air to the Colonial Products Laboratory* for BHC determination.

Results.—Detailed results showed that only about 0·4 and 0·6 parts per million of lindane remained of the original 20 and 80 parts per million respectively.

Observations and conclusions. The test applied was extremely stringent and differed from practice in the following respects:

1. The nuts were decorticated immediately after the application of insecticide and the samples were taken immediately after decortication. In practice there would be long periods of storage under tropical conditions, both before and after decortication, when part of the BHC could be expected to volatilize.
2. Single bags of heavily-treated nuts were dealt with. Normally, small, heavily-treated consignments would be mixed with a bulk of untreated or lightly-treated nuts from beneath the surface of seccos.

* Now re-named the Tropical Products Institute.

3. The machine used was old-fashioned and lacked the modern dust extraction apparatus of the two large mills which cope with a high proportion of the crop.

It is clear that the amount of lindane which is likely to be applied to undecorticated nuts can lead to no more than negligible contamination after decortication. Even after gross overdosing under the rigorous conditions described, less than 1 part per million of BHC could be detected in the final product. The 'Revised Code of Practice for Colonial Territories' issued by the Agricultural Research Council in 1951 and amended by the Stored Products Research Sub-Committee of the Committee for Colonial Agricultural, Animal Health and Forestry Research, in 1956, permits up to 2·5 parts per million of the gamma-isomer of BHC in the final product when prepared as food.

Acknowledgements

I would like to thank those authorities and individuals in the Gambia, who contributed to the undertaking of this investigation, and my colleagues at the Pest Infestation Laboratory who undertook the examination of samples sent back to the Laboratory.

References

(1) Green, A. A., 'The control of insects infesting groundnuts after harvest in the Gambia: I. A study of the groundnut borer, *Caryedon gonagra* (F.) under field conditions.' *Tropical Science*, 1959, **I**, No. 3, 200-205.

(2) Appert, J., 'Les insectes de l'Arachide au Sénégal.' *Bull. Cent. Rech. agron. Bambey*, 1953, No. 7, 67.

(3) *Pest Infest. Res.*, 1954, 18.

The Production and World Trade in Fresh Pineapples

By Mrs. D. E. Kay and E. H. G. Smith

Pineapples are widely grown in many tropical and subtropical countries but unlike most other fruits a large proportion of the world output is used for canning and in some areas the commercial crops are almost exclusively grown for the processing industry. It has been estimated that the ratio of fresh to canned pineapples sold in world markets is of the order of 1 to 10. Details of the world production of pineapples are difficult to obtain but Table I gives particulars of the output in the principal producing countries for the years 1954 to 1958 (1938 figures have also been included for comparison). The chief producing countries, in approximate order of importance are Hawaii, Brazil, Mexico, the Federation of Malaya, Formosa, the Philippine Republic, Cuba and the Union of South Africa. In addition to the countries listed in Table I, moderate quantities of pineapples are grown on a commercial scale in the West Indies, East and West Africa, Peru and the Azores.

The main countries exporting fresh pineapples, however, are Cuba, Mexico, Brazil, the Union of South Africa, the Azores, Guinea (formerly French Guinea) and the Ivory Coast. Before the war, in 1938, world exports were estimated to have amounted to some 58,200 tons of which Cuba supplied 43,000 tons, or 74 per cent. of the total. In the years immediately after the war Mexican exports increased considerably and reached a record level of some 38,000 tons in 1948, a year in which Cuba had an exceedingly small crop. In 1951, however, exports from both these countries dropped sharply and shipments from Cuba have remained below their pre-war level, averaging some 35,700 tons for the five-year period 1954 to 1958. Mexican exports have tended to recover in recent years and have averaged some 20,000 tons for the years 1954 to 1958 compared with 5,900 tons in 1938. Both countries ship the bulk of their fruit either to the United States or Canada. Brazilian exports of fresh pineapples have expanded considerably in post-war years and reached the record level of 18,900 tons in 1954, since when they have fallen. In 1958 some 9,800 tons of fresh pineapples were exported from Brazil, compared with 3,600 tons in 1938. The bulk of the Brazilian fruit is consigned to the Argentine Republic, although small shipments are made to Europe.

Pineapple exports from the Azores have remained below their pre-war level in recent years and in 1958 amounted to some 2,500 tons, compared with 3,600 tons in 1938. Relatively large quantities of Azores pineapples are shipped to the Portuguese mainland, but the United Kingdom, the Federal Republic of Germany and France are also important outlets.

In post-war years, an important trade in the export of fresh pineapples has been developed from the Union of South Africa. This fruit is mainly consigned to the United Kingdom although small quantities are marketed in Rhodesia and Nyasaland. South African exports of fresh pineapples totalled some 4,800 tons in 1953, since when they have fallen, and only amounted to 2,300 tons in 1957, but in 1958 there was a marked recovery and exports totalled some 3,500 tons of which 93 per cent. were consigned to the United Kingdom. The export of fresh pineapples has also been developed from Guinea and the Ivory Coast in post-war years, and, as would be expected, the bulk of this fruit is consigned to France. Details of the export trade in fresh pineapples for the years 1938 and 1954 to 1958 are set out in Table II while Table III gives particulars of imports into the principal consuming countries over the same period.

The United States is the largest importer of fresh pineapples and although consumption in that country has been heavier in recent years compared with 1938, it is still very much below that of the years immediately after the war, when annual average imports were in the region of 52,000 tons. In 1958, imports amounted to some 44,800 tons and were obtained mainly from Cuba and Mexico, the traditional sources. In addition, substantial quantities of fresh pineapples are also shipped to the United States from the non-contiguous American territories of Puerto Rico and Hawaii.

The Argentine Republic is the second most important market for fresh pineapples and receives its supplies almost exclusively from Brazil. In recent years, however, owing to the economic position of the Argentine, the trade has fluctuated considerably. In 1956, imports of fresh pineapples amounted to some 23,300 tons, but fell to 7,900 tons in 1957; in 1958, however, there was a slight recovery when 9,500 tons were imported.

Canada has been the third most important market for fresh pineapples although consumption has fallen in recent years; for example, during the five-year period 1954 to 1958, annual imports have averaged some 5,500 tons compared with 6,200 tons in 1938.

Pineapples are not separately classified in the official trade returns of many European countries but, with the exception of the United Kingdom, France, the Federal Republic of Germany, and possibly of Switzerland, imports are not large and it is generally considered that consumption is almost static in most countries. French imports of fresh pineapples largely from West Africa, particularly Guinea, have more than doubled between the years 1954 and 1957, rising from 1,200 tons to 2,700 tons in this period. This expansion of the trade would appear to be continuing since in 1958 annual imports into France rose to 4,700 tons and provisional figures for 1959 shows that there has been a further increase to 6,800 tons.

The growth in the consumption of fresh pineapples in the United Kingdom has been an interesting feature of the fruit trade in the post-war years. Annual imports for the five-year period 1954 to 1958, have averaged some 3,800 tons compared with 2,900 tons in 1938. However, this is below the annual figures for the years 1952 and 1953 when imports

were at a very high level indeed (partly due to shortages of canned pineapple). In 1953, shipments of fresh pineapples to the United Kingdom reached the record level of 5,600 tons, but in the following five years there was a steady decline in the quantity of fruit received on this market, and in 1957 imports had fallen to 3,200 tons. In 1958, total imports increased to 5,100 tons; consumption, however, was not maintained at this rate since, in 1959, there was a drop of 18 per cent. in total imports compared with those of the previous year.

In post-war years the Union of South Africa has provided the bulk of the pineapples marketed in the United Kingdom, for example in 1959, some 78 per cent. were obtained from this source. In most years the Azores is the second most important supplier and annual imports for the years 1955 to 1959 have averaged some 10,000 hundredweight. In recent years, however, exports from Jamaica have increased considerably, and in 1958, United Kingdom imports from that island exceeded those from the Azores, but in 1959 these were very much reduced. In addition, supplies of fresh pineapples are also obtained from Kenya and from time to time from Cuba and Brazil, while, in 1959, 2,000 hundredweight were received from Nigeria.

Although pineapples are available in the United Kingdom throughout the year, about 70 per cent. of the South African fruit is received during the months January to April, with shipments at their peak during February and March. At this period the market tends to be flooded with pineapples, and since it is very much a supply and demand trade prices drop, sometimes to a very low level indeed. Supplies from the Azores are received regularly throughout the year, although there is usually an increase in shipments during November and December when the demand for pineapples in the United Kingdom is greatest. Imports from Jamaica are received mainly during the summer months when there is only limited competition from the Union of South Africa. Table IV gives details of the monthly imports of fresh pineapples to the United Kingdom, and the chief countries of origin, for the years 1956, 1957, 1958 and 1959.

The export of fresh pineapples from the Union of South Africa is an extremely well-organized industry. Both the Queen and Smooth Cayenne varieties of pineapples are exported, although only about 15 per cent. of the total tonnage shipped consists of the Smooth Cayenne. The South African Queen pineapple is a very small fruit usually weighing between 1 and 2 lb. The trade consider that this is its chief disadvantage, since there is a much higher percentage of wastage than with the larger Cayenne fruit. When marketed in the United Kingdom good quality Queen pineapples are a pale yellow-golden colour and have a sweet flavour which some consumers regard as superior to that of other pineapples sold here. The South African Smooth Cayenne pineapples exported to the United Kingdom usually arrive on the market in a variable condition, in fact many importers are of the opinion that this variety is too delicate to stand up successfully to the sea voyage from the Union. The fruits commonly weigh between 3 and 4 lb. and when fully ripe are a more orange-red colour than Queen pineapples. For export to the United Kingdom

South African pineapples must be packed and graded to conform to the regulations promulgated under the Fruit Export Act 1914, and published in the *Government Gazette*, No. 5722, of 27th July, 1956. These regulations specify the size of fruit which may be exported and the size and type of packing case which must be used.

South African pineapples are transported to the United Kingdom in cold storage and the effect of various shipping temperatures on the quality of the fruit on arrival in the United Kingdom has been studied. As a result of a series of investigations it was discovered that the fruits of neither the Queen nor the Smooth Cayenne will successfully withstand storage at temperatures below 45°F. for any length of time. At temperatures below 45°F. the fruit became dull in colour, the leaves of the crowns became loose and the flesh was liable to develop a waterlogged appearance. At storage temperatures above 50°F., it was found that the flavour improved but there was excessive wilting of the crown leaves, particularly with Smooth Cayenne fruit and in addition the post-shipment life of the pineapples was too short for the fruit to be of any commercial value. As a result of these storage trials it was considered that a temperature of 47·5°F. gave the optimum results.

The Azores grow the St. Michael pineapple, a type of Smooth Cayenne, under glass for export as a luxury fruit to Europe. The industry, which has been carried on for a long time, is well established and the production and export of the fruit is very well organized. In the opinion of the fruit trade in the United Kingdom the Azores pineapple is the best pineapple on the market and other exporting countries cannot compete in marketing fruit of such uniform appearance and consistent good quality. The pineapples usually weigh between 5 and 6 lb. each and when ripe are a bright yellow-red colour. The fruit often arrives on this market showing a fair amount of green but colours very quickly and successfully. The flesh of the St. Michael pineapple is yellow and reasonably sweet in flavour, although some people consider that it is rather insipid. Many buyers are of the opinion that the crown of the Azores pineapple is too small and that it makes the fruit rather unattractive, although, when compared with Smooth Cayenne pineapples from other sources, the Azores fruit appears very much bigger and better value. Another advantage of these pineapples is that their cores are very small and, therefore, there is less wastage when the fruit is cut into portions. For export the St. Michael pineapples from the Azores are carefully graded as follows:

Grade	*Minimum Length*	*Minimum Diameter*
Extra Choice	$7\frac{1}{2}$ in.	$5\frac{29}{32}$ in.
Choice	$6\frac{5}{16}$ in.	$5\frac{1}{2}$ in.
Standard	$5\frac{1}{2}$ in.	$4\frac{23}{32}$ in.

The fruit is usually shipped in shallow wooden boxes whose measurements are approximately 41 × 21 × 9 in., although in recent years exporters have also been using what is termed a half box, the dimensions of which are approximately 21 × 20 × 9 in., since this size of container is favoured by European buyers. The large box of Azores pineapples contains from 8 to 16 fruits, graded according to size, and the half box from 4 to 7 fruits. The fruit is packed on wood wool, or pine twigs, which

are sometimes covered with blue tissue paper to improve the appearance of the pack. The pineapples are covered with a further layer of wood wool to protect them.

In recent years Jamaica has developed the export of pineapples to the United Kingdom. The fruit is the Red Spanish variety and usually weighs from 1½ to 2 lb. Unfortunately, when marketed in the United Kingdom, the Jamaican fruit often has a dullish yellow-red colour which detracts from its appearance and many people regard its flavour, which has been described as "woody", as inferior to the Queen or Smooth Cayenne varieties. However, the fruit is much less susceptible to handling injuries than the Smooth Cayenne, and on the whole consignments are much more uniform in quality than those received from the Union of South Africa.

For the fresh fruit market, colour and aroma are the leading quality characteristics of the pineapple, since the fruit is purchased entirely by its appearance. When fully ripe and fresh, the pineapple should have a clean bright appearance and the colour may vary according to variety from a gold yellow shade to a deep orange red, almost coppery shade. The appearance of the crown is also indicative of the quality of the fruit, the crown leaves should be turgid and a full green colour. Leaves which are turning brown on the edges or are limp detract from appearance and reduce the market value of the fruit. Pineapples with bent, crooked or double crowns should not be shipped to this market since they can only be sold at a discount. The size of the crown is also of importance, especially with the large Smooth Cayenne fruit sold to high-class hotels and restaurants, since a high proportion of this fruit is used for decorative purposes. A very small crown detracts from the appearance of the pineapple, while a very luxuriant crown makes packing difficult and also increases the proportion of inedible material purchased by the consumer.

Pineapples cannot always be successfully ripened artificially, fruit which has been harvested too immature often has an acidulous taste, and after it colours it sometimes develops a rather distinctive yellow tinge. Pineapples are a very "temperamental" fruit and there are many difficulties that have to be overcome if supplies are to be marketed in a perfect condition in the United Kingdom. Great care in the harvesting and subsequent handling of the fruit is absolutely essential, and it is widely recommended that pineapples should only be picked in the coolest part of the day; in addition it has also been suggested that the fruit should be left over-night in an open, dry, shady place to cool before it is packed for shipment. If the fruit is harvested when it is moist, it should be thoroughly dried before it is packed, otherwise mildew may develop on the outside. For protection during shipment it is usual for the pineapples to be cut with a small portion of the stalk attached to protect the base of the fruit. In spite of their robust appearance, pineapples are very easily damaged and if handled carelessly can quickly develop bruises, which may or may not show clearly on the outside skin. Unfortunately, the internal flesh around the bruised area of the fruit becomes watery and discoloured and may bleed juice both internally and externally.

The United Kingdom market for fresh pineapples may be divided into two categories, the luxury trade which is firmly held by the Azores fruit, and the cheaper normal retail trade which is dominated by the South African Queen fruit. In the luxury trade, size and appearance are of paramount importance. Fruit of between 4 and 6 lb. is usually favoured by buyers and flavour would seem to be of rather secondary importance. There is an all-the-year-round demand for this high-class fruit, although consumption is at its heaviest around the Christmas period when a large number of formal dinners and similar functions is being held. Producers in Kenya have attempted to break into this luxury market by shipping Smooth Cayenne fruit by air to the United Kingdom in recent years. Difficulties, however, have been experienced in ensuring that the fruit always arrives here in first-class condition. Nevertheless, the quality of certain shipments of Kenya pineapples has been very good and comparatively high prices have been realized, which are necessary to justify the cost of air-freight charges. Occasionally large Smooth Cayenne pineapples from other sources are sold to the luxury trade, but they usually fetch prices below those of the Azores pineapples and as the market is extremely susceptible to over-supply, this large fruit sometimes has to be sold at very low prices.

The bulk of the pineapples sold through normal retail channels to the domestic consumer consists of the South African Queen fruit which are often sold at between 1*s.* 0*d.* to 2*s.* 0*d.* each. In recent years South African exporters have studied the prospects of expanding the United Kingdom market for a "cheap" pineapple. Now that other fruits, deciduous, berry and citrus, of excellent quality are plentiful, and supplies of canned pineapple are freely available at a very low price, they consider that it would be difficult to increase the demand for fresh pineapples. The trade here are of the opinion that the majority of the British public continue to regard fresh pineapples as a luxury fruit, and therefore too expensive for them, and that, in addition, many people are too conservative to try the "cheaper" South African Queen pineapple. Moreover, the quality of South African Queen pineapples has varied a good deal from season to season and some consignments have shown a great deal of internal breakdown and diseased tissue when cut open.

Prices paid for fresh pineapples on the United Kingdom market vary a good deal according to the condition of the fruit and the quantity available for sale at any one particular period. During February and March, there is a tendency for supplies to exceed demand and prices may fall considerably. A study of the prices quoted in the *Fruit, Flower and Vegetable Trades' Journal*, during 1959, indicates that, over the year, the wholesaler to retailer price paid for Azores fruit ranged from as low as 4*s.* 0*d.* to as high as 12*s.* 0*d.* a pineapple, with an average quotation of about 7*s.* 4*d.* a fruit. Kenya pineapples fetched from 4*s.* 0*d.* to 8*s.* 0*d.* each, although the average for the whole year was only just over 5*s.* 0*d.* a fruit. On the whole South African Queen pineapples realized slightly higher prices than the Smooth Cayenne from that source, when the value is calculated on the basis of a case. The average quotation for Queen fruit was 21*s.* 1*d.* per case of 14 to 24 fruits but the highest price

paid was 32*s.* 6*d.* and the lowest 14*s.* 0*d.* Prices paid for South African Smooth Cayenne fruit ranged from 12*s.* 0*d.* to 25*s.* 0*d.* for a case of 6 to to 10 fruits, while the average quotation was 19*s.* 5*d.* a case. During the summer months Jamaican pineapples fetched between 22*s.* 0*d.* and 24*s.* 0*d.* a case of 8 to 12 fruits while a small consignment of Nigerian Smooth Cayenne pineapples which arrived on the London market during June sold for 18*s.* 0*d.* to 22*s.* 4*d.* a case of 6 to 8 fruits. There has been a tendency for the prices of South African pineapples to fall on the United Kingdom market in recent years, and it is understood that, if the trade is to be economic, the fruit should realize about 20*s.* 0*d.* per case. Even at this level it is estimated that the return to the grower is probably less than 8*s.* 0*d.* a case, when transport, packing and other charges have been deducted.

TABLE I

*Output of Pineapples in the Principal Producing Countries**

Quantity thousand tons

	1938	1954	1955	1956	1957	1958
Hawaii (a)	574	760	790	790	700	780
Brazil	131	165	186	191	199	218
Mexico	35	122	136	156	150	150
Malaya (b)	120	71	78	122	128	140
Formosa	114	65	70	82	97	136
Philippine Republic	9	98	102	105	107	114
Cuba (a)	66	90	90	100	100	100
Union of South Africa	9	(a) 55	47	53	106	(a) 100
Australia	28	62	69	83	69	76
Puerto Rico	17	23	27	28	35	40
TOTAL	1,103	1,511	1,595	1,710	1,691	1,854

* Source *Fruit*, 1960 [Commonwealth Economic Committee].
(a) Approximate, unofficial estimates.
(b) In post-war years deliveries to the canneries.

TABLE II

*Exports of Pineapples**

Quantity thousand tons

	1938	1954	1955	1956	1957	1958
Cuba	43·0	29·6	35·2	38·4	37·5	38·0
Mexico	5·9	21·7	21·4	19·8	18·8	18·7
Brazil	3·6	9·7	18·9	11·8	11·0	9·8
Union of South Africa	0·7	2·7	2·9	2·4	2·3	3·5
Guinea/Ivory Coast	—	1·0	1·5	2·0	2·7	2·5
Azores	3·6	1·9	1·9	2·1	2·4	2·5
Jamaica	—	—	—	0·3	0·9	1·0
United States	0·8	0·3	0·7	0·5	0·5	(b)
Australia (a)	0·6	—	—	0·1	—	(b)

* Source *Fruit*, 1960 [Commonwealth Economic Committee].
(a) Fiscal year ending June 30th.
(b) Not available.

TABLE III

*Imports of Pineapples**

Quantity thousand tons

	1938	1954	1955	1956	1957	1958
United States	39·1	40·4	46·8	43·7	43·1	44·8
Argentine Republic	3·0	4·7	13·1	23·3	7·9	9·5
United Kingdom	2·9	3·4	3·7	3·3	3·2	5·1
France	0·6	1·2	1·8	1·8	2·7	4·7
Canada	6·2	5·6	6·4	6·2	4·9	4·6
Federal Republic of Germany	—	0·7	0·7	0·7	0·9	1·4
Switzerland	—	0·4	0·4	0·6	0·6	0·6
Chile	0·6	0·3	0·6	0·4	0·3	0·4
New Zealand	0·8	0·1	0·3	0·1	0·1	0·2

* Source *Fruit*, 1960 [Commonwealth Economic Committee].

TABLE IV

*United Kingdom: Monthly Imports of Fresh Pineapples**

Quantity cwt.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1956													
Azores	499	193	282	372	572	300	168	438	601	1,964	355	3,935	9,679
Other Foreign Countries	73	40	—	76	—	—	145	—	—	—	—	11	345
Union of South Africa	4,959	12,420	9,682	2,752	3,128	3,993	6,489	1,559	206	526	655	2,123	48,492
Jamaica	(a)	230	205	208	207	2,953	2,183	43	—	—	225	297	6,779
Other Commonwealth Countries	228	5	3	34	48	26	68	197	27	156	61	168	793
Total	5,759	12,888	10,172	3,442	3,955	7,272	9,053	2,237	834	2,646	1,296	6,534	66,088
1957													
Azores	699	562	431	150	758	385	397	430	822	1,349	2,069	1,868	9,920
Other Foreign Countries	—	65	—	—	—	—	—	—	—	—	—	40	105
Union of South Africa	1,409	14,954	12,684	5,184	3,053	1,309	1,136	3,127	1,292	285	216	254	44,903
Jamaica	(a)	330	1,215	1,456	355	1,156	1,378	160	58	138	121	394	7,401
Other Commonwealth Countries	889	185	80	63	64	33	69	244	266	37	41	55	1,386(b)
Total	2,997	16,096	14,410	6,853	4,230	2,883	2,980	3,961	2,438	1,809	2,447	2,611	63,715
1958													
Azores	897	279	277	355	279	221	305	369	552	365	864	3,014	7,777
Other Foreign Countries	3	—	—	61	—	600	5	—	—	478	322	580	2,049(c)
Union of South Africa	14,494	31,362	21,359	3,382	1,652	480	689	857	3,142	3,978	249	150	82,122
Jamaica	(a)	338	1,580	1,083	2,686	2,214	14	—	—	—	313	138	8,676
Other Commonwealth Countries	536	205	33	—	110	1	141	386	134	111	61	109	1,517(d)
Total	15,930	32,184	23,249	4,881	4,727	3,516	1,154	1,612	3,828	4,932	1,809	3,991	102,141
1959													
Azores	769	133	337	605	(e)	286	163	611	1,017	1,607	1,370	4,936	12,438
Other Foreign Countries	—	—	—	—	(e)	—	—	—	—	82	138	406	545
Union of South Africa	8,398	20,252	11,456	4,220	(e)	2,331	2,259	2,256	2,466	4,122	2,021	1,302	65,682
Jamaica	(a)	85	—	—	(e)	898	1,056	—	—	—	—	—	2,321
Other Commonwealth Countries	318	334	150	559	(e)	634	438	574	76	26	39	344	3,624(f)
Total	9,485	20,804	11,943	5,384	5,617	4,149	3,916	3,441	3,559	5,837	3,568	6,988	84,610

* Abstracted from monthly issues of *Fruit Intelligence*.

(a) Not available; imports, if any, included with Other Commonwealth Countries.
(b) Kenya, 1,298 cwt.
(c) Cuba, 1,688 cwt.
(d) Kenya, 1,284 cwt.
(e) Not available.
(f) Kenya, 1,586 cwt.

The Production of Hardboard from Tropical Timbers*

V. Mugongo *(Ricinodendron rautanenii)*

By D. F. Packman

Forest Products Research Laboratory

Summary

Standard and super hardboards to the requirements of B.S. 1142 (1953) were made on an experimental scale from Mugongo (*Ricinodendron rautanenii*) by the Defibrator process and by a simpler method involving the use of the disc mill, with no prior steaming or chemical treatment. Boards which, after an oil-tempering treatment, met all the specification requirements were made from unrefined pulp, prepared in high yield by wet-grinding the untreated green chips. Boards made from refined pulp and from pulp prepared by the Defibrator technique, although having higher initial strength, also required oil-tempering in order to meet the specification for water resistance.

Introduction

Mugongo grows in south tropical Africa and as far south as Rhodesia and Bechuanaland. It is a very light-weight, pale-coloured wood, liable to considerable discolouration by staining fungi. The average density for the species is reported to be 11 lb./cu. ft. when seasoned. The wood finds little commercial application as a constructional material on account of its very low density and poor strength properties.

Material

The wood for this investigation, in the form of small logs of 12 in. average diameter, was obtained from Northern Rhodesia. It was heavily blue-stained and had a bulk density of 13 lb./cu. ft. measured at 10 per cent. moisture content. As received, the logs were green. In this condition they were readily chipped in the laboratory chipper[1] yielding good clean-cut chips with a moisture content of 220 per cent. on dry weight basis.

Experimental

(1) Wet-Grinding Process

Owing to the softness of the wood it was found possible to defibre the green chips directly in the Sprout-Waldron laboratory disc mill, at ordinary temperature and without preliminary treatment. Air-dried chips

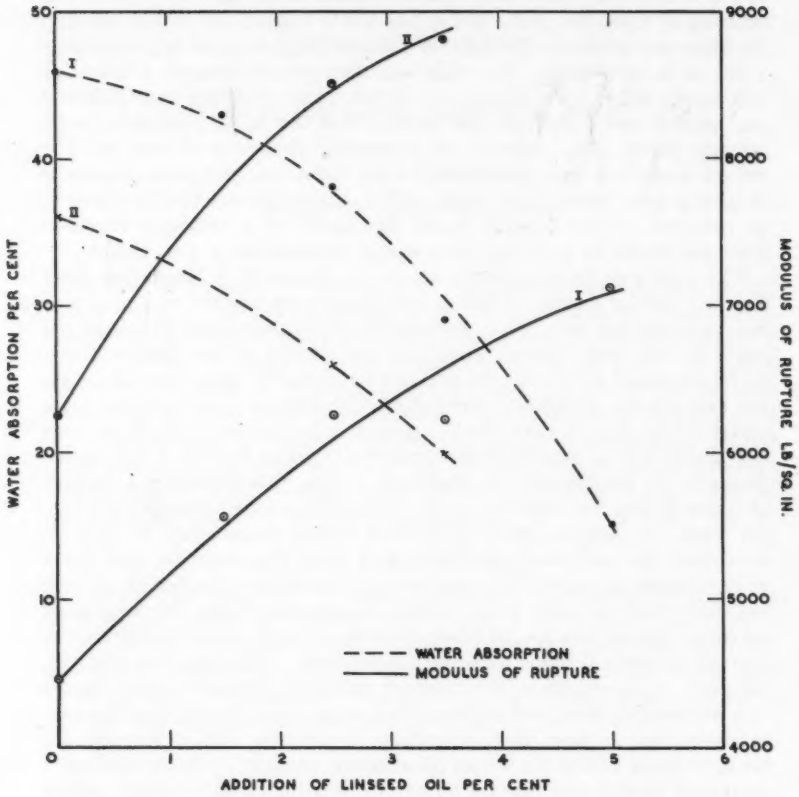
* See also *Colon. Pl. Anim. Prod.*, 1954, **IV**, No. 4, 293; 1955, **V**, Nos. 1 and 2, 39, 137; and *Tropical Science*, **I**, No. 1, 5.

responded to the same treatment but required rather more power and tended to produce more finely divided fragments. Coarse plates, Nos. 17779 and 17780, were used with a nominal clearance of ·003 in. and running at 1,360 rev./min. Water was fed to the mill at such a rate that the fibre was ejected in the form of a coarse pulp slurry of approximately 7 per cent. consistency. The pulp was then passed through a vibrating wet screen fitted with a ·040 in. slotted plate. Rejects were collected and passed again through the Sprout-Waldron mill, now fitted with refining plates, Nos., 12527A, at a nominal clearance of ·005 in. The refined screenings were re-mixed with the main bulk of screened material to give a very free-running pulp with a dry fibre content equivalent to 91 per cent. of the original wood. Measured on a Williams Precision Freeness Tester its drainage time was 11 seconds for a 5 g. sample.

The pulp was formed into mats 10 in. square in a laboratory sheet former, without further refining, and these were pressed to $\frac{1}{8}$ in. thick boards in the hot press for 10 minutes at 185°C. and 1,000 lb./sq. in. To avoid blisters and "water burns" on the surface of the boards it was found necessary to release the pressure temporarily for 30 seconds, after the first minute, to allow "breathing". The boards thus produced were found to have high water absorbency and rather low strength. They were not acceptable as Standard Hardboard according to B.S. 1142, which required, for boards of $\frac{1}{8}$ in. thickness, a minimum modulus of rupture of 4,900 lb./sq. in. together with a maximum water absorption of 30 per cent. by weight, under prescribed testing conditions. As may be seen from the test results in Table I, a heat treatment for two hours in circulating air at 180°C. improved the qualities of the boards though not sufficiently to bring them within the required limits. Previous work on other species had shown oil-tempering to be the most satisfactory of various methods of reducing water absorption[2]. Oil-tempering with 3·5 per cent. of linseed oil in this instance raised the strength of the boards to a satisfactory value and reduced their water absorption just sufficiently to allow them to pass the specification. Tempering with 5 per cent. oil brought them within the Super Hardboard category, which requires a minimum modulus of rupture value of 5,600 lb./sq. in. together with a maximum water absorption of 20 per cent. The tempering treatment was carried out by applying the required amount of oil, in the form of a fine spray, uniformly to both sides of the boards immediately after their removal from the hot press. The boards were then heat-treated in circulating air at 180°C. for two hours (Fig. I).

Further refinement of the coarse pulp was attempted by a variety of treatments in the disc mill. Difficulty was experienced, however, due to the tendency of the material to disintegrate and form very small fragments. A reproducible result was finally obtained by first draining the pulp to a meal of 20 per cent. dry fibre content and passing it in this form through the disc mill using refining plates No. 12527A, at a nominal clearance of ·005 in., water being added in the mill so that the refined pulp emerged as a slurry of 4 to 5 per cent. consistency. By regulation of the feed a steady rate of power consumption was maintained and a uniform product obtained. The refined pulp contained a proportion of

FIG. 1 BOARDS FROM MUGONGO. I WET-GRINDING PROCESS. EFFECT OF OIL-TEMPERING WITH LINSEED OIL



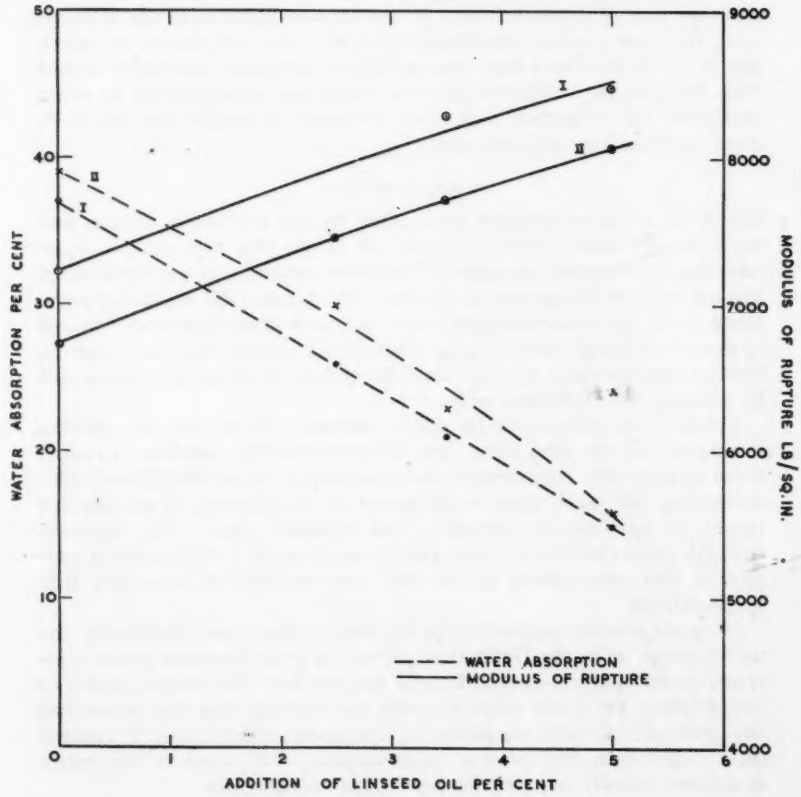
extreme "fines" however, and its drainage time of 57 seconds for a 5 g. sample was considered too slow for practical sheet-forming requirements. By blending approximately equal quantities of the refined pulp with the original unrefined stock a pulp was produced which had an intermediate drainage time of 30 seconds for 5 g. The yield of this part-refined blended pulp appearing finally in the form of dry boards was equivalent to 80 per cent. of the original wood. Losses were presumably due to very fine material which was not retained in the sheet-forming stage. The power consumed in the refining stage, based on dry fibre content of final blended pulp, was two-thirds of that consumed to produce an equivalent weight of unrefined fibre from chips. The total power consumed to produce the blended pulp was thus 1·66 times that required for the initial defibring treatment.

As is shown in Table I, boards made from this blended pulp had higher strength properties than those made from the original unrefined fibre but their water absorption was still undesirably high. Heat treatment alone was not sufficient to bring them within the acceptable limits, but tempering with small additions of linseed oil had the desired effect.

(2) Defibrator Process

Chips were readily defibred in the laboratory Defibrator, at 150 lb./sq. in. steam pressure for 1½ minutes. Owing to the low density of the wood, batches of more than 300 g. dry weight were found to be too bulky. Even with this comparatively small quantity in the Defibrator a very high power consumption was recorded, probably due to the clogging effect of the large bulk of defibred material produced rather than to any marked resistance to defibration.

FIG.2 BOARDS FROM MUGONGO. II DEFIBRATOR PROCESS. EFFECT OF OIL-TEMPERING WITH LINSEED OIL



A free-draining pulp was produced with a dry fibre content equivalent to 80 per cent. of the original wood. This was wet-screened to remove shives, and boards were then pressed from the pulp without further refinement. The pressing conditions were the same as for the boards made from the wet-ground pulp described earlier. As may be seen from the test results in Table II the strength of these boards was more than adequate, though their water absorption was too high. Heat treatment alone effected considerable improvement but the water absorption was still a little above the specified maximum value. As with the wet-ground pulp, oil-tempering with small additions of linseed oil improved the properties of the boards to acceptable levels (Fig. II).

The shives and rejects from the wet screen were added to a portion of the screened pulp and the mixture was then refined in the disc mill under precisely the same conditions as those employed for the wet-ground pulp described earlier. The refined Defibrator pulp had similar characteristics to those of the refined wet-ground pulp, though its drainage rate was rather slower—75 seconds for a 5 g. sample. A blended mixture of this refined pulp with the original screened stock was prepared with a drainage time of 30 seconds for 5 g. Boards were made from this mixture, using the same pressing conditions as before. Their test results are shown also in Table II. These show that no significant gain in strength resulted from the refining treatment, nor was there any improvement in water resistance. Oil-tempering was again necessary to enable the boards to meet specification requirements.

Conclusions

Boards of adequate strength were made by the Defibrator process and by a simpler method involving the use of the disc mill without prior steaming or chemical treatment. The latter method was successful when applied to green chips owing to the very soft nature of the wood. A general tendency of the wood to break down into very small fragments resulted in somewhat lower yields of pulp from the Defibrator and some losses in refining treatments in the disc mill. No practical advantage was gained by refining the Defibrator pulp.

Boards from pulp made by either method, with or without refining treatment, all required some form of waterproofing additive to enable them to meet B.S. requirements for Standard or Super Hardboard. Oil-tempering with small amounts of linseed oil was found to be an effective means of securing the necessary improvement. Since this improved strength properties at the same time, boards made from unrefined wet-ground fibre and treated in this way were enabled to meet both B.S. specifications.

No great practical advantage in the final product was obtained by the use of steam, as in the Defibrator process, or from the extra power consumed in refining wet-ground fibre in the disc mill. The simple process of wet-grinding the green chips followed by oil-tempering the boards has the merit of high yield coupled with low power consumption. If applied on a large scale, this process could dispense with some of the costly equipment usually required for hardboard manufacture.

Acknowledgement

The research upon which this communication is based was carried out as part of the programme of the Forest Products Research Board on behalf of the Colonial Products Council. It is published by permission of the Department of Scientific and Industrial Research.

References

(1) Farmer, R. H., and Packman, D. F., "The Production of Hardboard from Tropical Timbers. II". *Colon. Pl. Anim. Prod.*, 1955, **V**, No. 1, 39-50.

(2) Packman, D. F., "The Production of Hardboard from Tropical Hardwoods". Seventh British Commonwealth Forestry Conference, 1957.

Table I

Boards Made from Mugongo by Wet-Grinding Process

	Pulp								Boards			
		Fibre Classification (per cent. of dry weight)										
	Pulp Yield *per cent.*	Above 10 Mesh	10/14 Mesh	14/25 Mesh	25/52 Mesh	52/100 Mesh	Below 100 Mesh	Freeness Williams (sec. for 5·0 g.)	Tempering treatment	Specific Gravity	Modulus of rupture (lb./sq. in.)	Water Absorption *per cent.*
I Unrefined Wet-ground fibre	91	27	9	21	14	9	20	11	Nil	1·00	3,865	79
									Heat only	0·97	4,458	46
									1·5 *per cent.* oil	1·00	5,563	43
									2·5 *per cent.* oil	1·01	6,253	38
									3·5 *per cent.* oil	1·02	6,215	29
									5·0 *per cent.* oil	1·05	7,110	15
II Part-refined blended pulp	80	20	8	22	19	11	20	30	Nil	1·05	5,958	51
									Heat only	1·02	6,250	36
									2·5 *per cent.* oil	1·09	8,510	26
									3·5 *per cent.* oil	1·10	8,820	20

TABLE II

BOARDS MADE FROM MUGONGO BY DEFIBRATOR PROCESS

	Pulp								Boards			
		Fibre Classification (per cent. of dry weight)										
	Pulp Yield *per cent.*	Above 10 Mesh	10/14 Mesh	14/25 Mesh	25/52 Mesh	52/100 Mesh	Below 100 Mesh	Freeness Williams (sec. for 5·0 g.)	Tempering treatment	Specific Gravity	Modulus of rupture (lb./sq. in.)	Water Absorption *per cent.*
I Unrefined fibre	80	24	7	16	22	14	17	13	Nil	1·06	6,130	56
									Heat only	1·04	7,230	37
									2·5 *per cent.* oil	1·07	7,470	26
									3·5 *per cent.* oil	1·09	8,290	21
									5·0 *per cent.* oil	1·09	8,470	15
II Part-refined blended pulp	76	15	7	15	23	15	25	30	Nil	1·06	6,360	57
									Heat only	1·02	6,740	39
									2·5 *per cent.* oil	1·05	7,465	30
									3·5 *per cent.* oil	1·05	7,710	23
									5·0 *per cent.* oil	1·07	8,060	16

Pulping Trials on *Ricinodendron rautanenii* Timber from Northern Rhodesia

By A. E. Chittenden, Miss E. E. L. Edwards and E. R. Palmer

Introduction

Ricinodendron rautanenii (Mugongo), a member of the Euphorbiaceae, grows prolifically along the Zambezi River for several hundred miles upstream from the Victoria Falls. It also occurs naturally in other parts of tropical Africa. In Rhodesia it is stated to be easily propagated and fairly fast-growing. Moreover, in the areas where it occurs naturally or where it could be grown, electric power, rail transport, coal and water are available.

It was considered, therefore, that it would be worth while carrying out pulping trials on the timber, with the possibility in mind of future commercial exploitation for pulp production. *R. rautanenii* is little used commercially as timber (except for the local manufacture of curios), although the Forest Products Research Laboratory, Princes Risborough, considers it suitable for the production of plywood cores.

The original samples of timber were badly infected with sap-stain fungus when received at the Tropical Products Institute.

Before the actual pulping trials on this timber, it was considered desirable to see whether fungus-free timber could be obtained. Consequently, several batches of the timber were sent for examination in an attempt to elucidate the extent and effect of sap-stain fungus in the timber. A brief description and history of these samples is given below:

Group 1

(Original Samples)

This group consisted of 16 logs, each 10-15 in. in diameter and 4ft. 6 in. long. They had been divided into three series, 'A' (4 logs), 'B' (7 logs) and 'C' (5 logs). All these samples were drilled to provide material for chemical analysis, but only the 'C' series logs were used for pulping trials. Superficially, the 'C' series samples appeared quite sound, but when chipped traces of sap-stain fungus were apparent and, in one sample, live pinhole borer beetles were found.

Group 2
(Four billets sent by air)

These samples consisted of four billets of timber of 4 in. square cross-section and 2 ft. 6 in. in length. They had been treated within 30 minutes of felling with a sodium pentachlorphenate/borax fungicide supplied by the Tropical Products Institute. These billets were labelled A1, A2, B1 and B2 and were stated to have been obtained from trees similar to those from which the original 'C' series logs were obtained. All four billets were, despite a lapse of only about 10 days between felling and receipt, attacked by sap-stain fungus.

Group 3
(Six logs sent by surface transport)

These logs were all 3 ft. long and varied in diameter between 9 and 19 in. They had been treated on the butt ends with the same sodium pentachlorphenate/borax mixture as the billets described in Group 2 above, but had also been attacked by sap-stain fungus. The logs were labelled C1, C2, C3, D1, D2 and D3.

Other treated and untreated samples of *R. rautanenii* timber were sent by air and surface transport but all on arrival showed signs of fungal attack.

Sampling

In the first instance small samples suitable for chemical analysis were obtained from the 16 logs described in Group 1, by drilling and collecting small chips. These chips ('drillings') were then ground for analysis to pass a B.S. 40 mesh sieve but to be retained on a B.S. 60 mesh sieve. In addition all the 'C' series logs of Group 1 were converted into billets and then chipped in a two-knife disc chipper for pulping trials.

In the same way, billets A1 and B2 of Group 2 and logs C3 and D3 of Group 3 were machine-chipped for pulping trials.

Physical Examination

The apparent density of offcuts from the Group 1 'C' series logs and of pieces cut from billets A1 and B2 of the Group 2 samples was determined by the *Tappi* standard method T. 18m.–53, and the results are shown in Table I. As will be seen the average apparent density of the samples of *R. rautanenii* measured is about 11 lb./cu. ft. This indicates that it is a very light timber.

Chemical Analysis

In order to obtain some idea of the extent and effects of the fungal attack on the Group 1 samples, a 1 per cent. alkali solubility (*Tappi* Standard method T. 4m.–54) was carried out on the ground 'drillings' from each log. The results are shown in Table II. The amount of material in the wood which is soluble in 1 per cent. alkali is not very high but, in the absence of a 'control' unattacked sample, it is not possible to compare these results with those from fungus-free wood. In an attempt to obtain more data on this problem all the ground 'drillings' from the 'C' series samples were mixed in equal proportions by weight and subjected to a

more complete chemical analysis and the results are given in Table III. The holocellulose and α-cellulose figures for this timber are within the ranges normally encountered for hardwoods and consequently it appears that, on the face of it, the fibrous structure of the timber has not suffered greatly from the fungal attack. The ash obtained is, however, rather higher than would be expected from a timber of this type.

Microscopy of Ultimate Fibres

Ultimate fibres were prepared from the mixed 'drillings' obtained from the Group 1 'C' samples. The sodium chlorite maceration method was used to produce these ultimate fibres.[1]

The dimensions of these ultimate fibres were measured by the projection microscope and the results are given in Table IV. The basic measurements of the fibres require little comment, but the calculated figure for the 'coefficient of suppleness' is considered to be worthy of further explanation. The usefulness of this expression in predicting the paper-making qualities of hardwood pulps was postulated by Peteri[2] when carrying out research on African tropical hardwoods. This has been elaborated by Istas[3] who gives the following classification obtained during his work on Belgian Congo hardwoods:

Using the 'Coefficient of Suppleness' of fibres, timbers can be classified into four categories:

(1) Fibres having a 'coefficient of suppleness' greater than 75. Timbers of low density (less than 28 lb. per cu. ft.) having fibres with thin cell walls and large lumen form part of this group. Paper-making characteristics: the fibres collapse (flatten) and produce a good surface contact. This results in good fibre/fibre bonding.

(2) Fibres having a 'coefficient of suppleness' between 75 and 50. Timber of medium density with cell walls and lumen of medium dimensions. Paper-making characteristics: the fibres only partially collapse, giving an elliptical cross-sectional form, also giving a good surface contact and fibre/fibre bonding.

(3) Fibres having a 'cofficient of suppleness' between 50 and 30. Medium to heavy timbers; with fibres having fairly thick walls and a rather narrow lumen. Paper-making characteristics: the fibres show only a small amount of flattening which in turn gives a fairly small surface contact and fairly poor fibre/fibre bonding.

(4) Fibres have a 'coefficient of suppleness' less than 30. Heavy and very heavy timbers; fibres with thick cell walls and a very narrow lumen. Paper-making characteristics: the fibres retain their circular form, they are rigid and have a very small surface contact and poor fibre/fibre bonding.

The very flexible fibres of the first category yield low bulk papers with excellent physical characteristics (burst, tensile, fold). The characteristics of the fibres in the fourth category indicate a yield of porous absorbent papers with poor physical characteristics.

It will be seen that, according to this classification, *R. rautanenii* timber is in category 1 and would be expected to yield pulps of medium to good strength.

Pulping Trials

Two series of pulping trials were carried out. The trials were restricted to the sulphate process which consists essentially of cooking the chips in a liquor containing sodium hydroxide and sodium sulphide. The cooks were carried out in an externally heated, rotating, stainless steel digester.

In the first series, chips from the 'C' series of Group 1 were used. Complete data for this trial is given in Table V. This shows that a series of cooks under identical conditions all produced a very low yield of dark-coloured pulp.

In the second series of trials a mixture of chips from samples A1 and B2 of Group 2 and C3 and D3 of Group 3 were used. These trials represented an attempt to improve on the pulp yield obtained in the first series and complete data for these trials are given in Table VI. Low yields of dark-coloured pulp were again obtained and the relationship between pulping conditions, yield and chemical consumption was erratic. These effects were probably due to the varying degrees of fungal damage on the timber.

The pulping conditions of the first series of trials (Table V) and of cook K54 (second series, Table VI) are identical and all these cooks yield similar results. Consequently it would appear that both groups of timber samples have been similarly affected by fungal attack.

Pulp Evaluation

Standard sheets were made from the pulp obtained in the first series of trials by means of the British Standard Sheet Machine, in order to evaluate the paper making properties of the pulp. The method used was that described in The Second Report of the Pulp Evaluation Committee of the Paper Makers' Association. Before testing, the sheets were conditioned to a relative humidity of 65 per cent. and a temperature of 70°F. The results of this evaluation, which was carried out in accordance with the official methods of the Paper Makers' Association, are given in Table VII.

It was decided that pulp evaluation tests would be carried out on pulps from the second series of trials only if the pulp produced was of a better yield and colour. Since this condition was not satisfied, no pulp evaluation tests were carried out on the second series of trials.

Bleaching Trials

Bleaching trials were carried out on pulp from K41B. A series of tests was carried out using a three-stage bleaching procedure. The proper bleaching procedure was determined by means of 'orienting' investigations on small quantities of pulp, according to the methods given in F.A.O. Forestry and Forest Products Study No. 6, 'Raw Materials for More Paper', F.A.O. Rome 1953. As a result of these 'orienting' studies pulp was bleached on a larger scale under the following conditions:

Bleaching Trials

Natural Chlorine Demand: 15 per cent.

Stage 1 *Chlorination*

15 per cent. chlorine on oven-dry pulp for 1 hour at room temperature (20°C.) at 3 per cent. stock consistency.

Stage 2 *Alkaline Extraction*

3 per cent. sodium hydroxide on oven-dry pulp for 1 hour at 60°C. at 5 per cent. stock consistency.

Stage 3 *Hypochlorite Bleach*

3 per cent. available chlorine (added as calcium hypochlorite) for 2 hours at 35°C. at 6 per cent. stock consistency with pH controlled between 8·5 and 9·5.

Total chlorine consumption on oven-dry unbleached pulp was 18 per cent., and this yielded 25 per cent. of bleached pulp (based on oven-dry raw material) with a brightness (Eel. filter 602) of 79 per cent. This represents a loss of yield on bleaching of 15 per cent. based on oven-dry raw material.

The chlorine consumption and loss of yield on bleachings are both very high, and together provide further evidence of the damage to the timber caused by fungal attack.

Pulp evaluation tests were carried out on the bleached pulp obtained by the methods given above, and the results are given in Table VIII.

Beating Effect

Unbleached pulp from K41A was used in a beating trial. The trial was carried out in a Valley Niagara beater (1½ lb.) having a weight of 5·5 kg. on the bedplate. The beaten pulp was evaluated by the same method as used for unbeaten pulp and the results are set out in Table IX. In general, the results of these trials show that, after comparatively short beating times, this material produced bulky papers having quite high tensile and burst strengths but possessing a poor tear strength. At the longer beating times there is a progressive decrease in both the tear strength and the freeness.

These are typical hardwood pulp characteristics and it can be inferred from these results that the damage due to fungal attack on this material had probably not extended to the individual fibres.

Remarks

1. All the samples which are the subject of this report, whether treated with fungicide or not, were attacked by a sap-stain fungus. It would appear, therefore, that it is very difficult to obtain fungus-free samples of this timber.
2. The effect of the presence of fungus in the timber was to cause very low yields of dark-coloured pulp to be obtained. These results are similar to those obtained by Luiz de Seabra and Manuel P. Ferreirinha[4]
3. The fungus which is the cause of sap-stain in the timber has been tentatively identified by the Commonwealth Mycological Institute as *Ceratocystis moniliformis* (Hedc.) G. Moreau (syn. *C. wilsoni*). Since the timber is attacked by this organism with great rapidity, there is the suspicion that it may exist in or on the living tree. This

would, however, have to be finally proved by further mycological studies.

4. It would seem, however, that if the problem of the susceptibility to fungal attack shown by this timber can be overcome, it shows some promise as a source of typical hardwood pulp.

Acknowledgements

The authors are indebted to Mr. K. Wilson-Jones, formerly of the Colonial Pesticides Research Committee for advice on fungicides suitable for treating the samples and to Dr. J. C. F. Hopkins of the Commonwealth Mycological Institute for his work on the sap-stain fungus found on these timbers.

References

(1) Spearin, W. E., and Isenberg, I. A., *Science*, 1947, **105**, No. 2,721, 214.
(2) Peteri, R., *Tappi*, 1952, **35**, No. 4, 157-60.
(3) Istas, J. R., Heremans, R., and Raekelboom, E. L., *I.N.E.A.C.*, Série Technique, 1954, No. 43, 29.
(4) *Estudos, Ensaios e Documentos VI Madeiras Coloniais*, Lisbon, 1950, 25-50.

Table I

Ricinodendron rautanenii

Apparent density expressed as $\frac{\text{Oven-dry weight*}}{\text{green (soaked) volume}}$

	g./cc.	*lb./cu. ft.*
Group 1, 'C' Series Samples (Logs)		
C1	0·19	11·9
C2	0·22	13·7
C3	0·18	11·2
C4	0·18	11·2
C5	0·16	10·0
Group 2, Samples (Billets)		
A1	0·18	11·2
B2	0·16	10·0

A factor of 62·4 was used to convert the apparent density in C.G.S. Units to lb./cu. ft.

* *Tappi* Standard Method T18 m.-53.

TABLE II

R. rautanenii

Group 1. *Samples (all logs)*

1 per cent. Alkali solubility on the 'drillings' from each log (*Tappi* Standard method, T4 m.–53)

Log	Solubility in 1 per cent. sodium hydroxide (expressed on moisture-free material)
	per cent.
A1	12·9
A2	12·3
A3	14·6
A5	15·7
B1 (2 logs mixed)	13·1
B2 (2 logs mixed)	12·5
B3	12·8
B4	15·8
B5	14·6
C1	10·4
C2	13·5
C3	10·7
C4	14·5
C5	11·7

TABLE III

R. rautanenii

Group 1. *'C' Series Samples*

Analyses carried out on mixed ground 'drillings' from all 'C' Series Samples

	per cent.
Moisture	7·8
Expressed on moisture-free material	
Hollocellulose	77·3
α-cellulose	48·3
Alcohol-Benzene extractives	1·7
Ash	2·2

The holocellulose was determined by the method of Wise, Murphy and D'Addieco (*Paper Trade J.*, 1946, **122**, No. 2, 35). The other chemical analyses were carried out according to the appropriate standard methods of the American Technical Association of the Pulp and Paper Industry.

TABLE IV

R. rautanenii

Group 1. 'C' Series Samples

Analyses carried out on mixed ground 'drillings' from all 'C' Series Samples

Mean Fibre Length, mm.	1·325 ± 0·038
Calculated range of fibre length,* mm.	1·249 to 1·401
Mean Fibre Diameter, microns	35·3 ± 1·6
Calculated range of fibre diameter,* microns	32·1 to 38·5
Mean fibre wall thickness, microns	4·15 ± 0·16
Calculated range of fibre wall thickness,* microns	3·83 to 4·47
Mean Lumen Diameter, microns (Calculated)	27·0
'Co-efficient of Suppleness'† (Calculated)	76

* Calculated range = 95 per cent. calculated limits based on Mean ± 2 × standard deviation, which is shown after the mean in each case.

† 'Co-efficient of Suppleness' = $\frac{\text{Diameter of Lumen} \times 100}{\text{Diameter of Fibre}}$

TABLE V

R. rautanenii

Group 1. 'C' Series Samples

Sulphate Cooks. Digestion Data

Cook Number		K41A	K41B	K41C
Effective Alkali as NaOH on oven-dry raw material, per cent.*		15	15	15
Sulphidity, per cent.†		30	30	30
Liquor to oven-dry raw material ratio		6 : 1	6 : 1	6 : 1
Maximum temperature, °C.		170	170	170
Time to reach maximum temperature, hour		1	1	1
Time at maximum temperature, hour		3½	3½	3½
Consumption of Effective Alkali on oven-dry raw material, per cent.		11·0	10·5	12·9
Yield of unbleached pulp	Screened pulp, per cent.	38·9	29·1	32·4
	Screenings, per cent.	0·8	1·5	1·4
	Total, per cent.	39·7	30·6	33·8

* Effective Alkali = NaOH + ½ Na_2S expressed as NaOH.

† Sulphidity = $\frac{Na_2S \times 100}{Na_2S + NaOH}$ Sodium compounds expressed as NaOH.

TABLE VI

R. rautanenii

Groups 2 and 3. Mixed Samples
Sulphate Cooks. Digestion Data

Cook Number		K49	K50	K51	K52	K54
Effective Alkali as NaOH on oven-dry raw material, per cent.*		20	15	12	12	15
Sulphidity, per cent.†		25	20	15	15	30
Liquor to oven-dry raw material ratio		6 : 1	6 : 1	6 : 1	6 : 1	6 : 1
Maximum temperature, °C.		170	170	170	170	170
Time to reach maximum temperature, hour		1	1	1	1	1
Time at maximum temperature, hour		3½	3½	3½	2½	3½
Consumption of Effective Alkali on oven-dry raw material, per cent.		13·6	10·9	9·2	9·9	10·2
Yield of unbleached pulp	Screened pulp, per cent.	33·0	26·3	22·8	24·9	30·7
	Screenings, per cent.	0·5	0·6	0·6	1·4	0·6
	Total, per cent.	33·5	26·9	23·4	26·3	31·3

* Effective Alkali = NaOH + ½ Na_2S expressed as NaOH.

† Sulphidity = $\frac{Na_2S \times 100}{Na_2S + NaOH}$ Sodium compounds expressed as NaOH.

TABLE VII

R. rautanenii

Group 1. 'C' Series Samples
Sulphate Cook. Unbleached, Unbeaten, Pulp Evaluation

Cook Number	K41A
Basis Weight, g./sq. metre	57·4
Thickness, microns	114
Bulk	1·99
Breaking Length, metres	3758
Stretch, per cent.	1·8
Burst Factor	17·3
Tear Factor	71·4
Drainage Time, sec.	4·7

TABLE VIII

R. rautanenii

Group 1. 'C' Series Samples

Sulphate Cook. Bleached, Unbeaten, Pulp Evaluation. (3-stage Bleach)

Cook Number	K41 B
Basis Weight, g./sq. metre	58·8
Thickness, microns	106
Bulk	1·80
Breaking Length, metres	3673
Stretch, per cent.	2·3
Burst Factor	17·7
Tear Factor	64·0
Drainage Time, sec.	4·5
Brightness (Eel Filter 602)	79

TABLE IX

R. rautanenii

Group 1. 'C' Series Samples

Sulphate Cook. Unbleached, Beaten, Pulp Evaluation. Valley Beater

Cook Number	K41A					
Beating Time, min.	0	5	10	15	20	30
Basis Weight, g./sq. metre	57·4	60·0	58·2	60·5	59·0	59·4
Thickness, microns	114	107	88	95	87	84
Bulk	1·99	1·79	1·67	1·57	1·47	1·41
Breaking Length, metres	3758	5927	6758	7323	8351	9719
Stretch, per cent.	1·8	2·4	2·8	2·9	3·2	3·8
Burst Factor	17·3	28·2	36·3	42·2	46·1	56·0
Tear Factor	71·4	80·1	84·3	74·9	77·2	75·7
Drainage Time, sec.	4·7	4·7	4·8	5·5	5·9	10·1

Pulping Trials on Three Species of Pine from Mauritius

By A. E. Chittenden and E. R. Palmer

The samples for this examination consisted of twenty logs which had been sent by the Conservator of Forests, Curepipe, Mauritius. The timber was accompanied by botanical material for submission to the Royal Botanic Gardens, Kew, for identification. Each log was approximately 2 ft. 6 in. long and 6 in. to 12 in. in diameter. The logs, which were complete with bark and wrapped, in pairs, in sacking, had been treated on the cut ends with Lignox (a solution of pentachlorphenol in light oil). Details supplied by the Conservator of Forests are as follows:

Group 1. Logs labelled 1–4 *Pinus taeda*, age about 25 years, from the Arboretum, Curepipe.

Group 2. Logs labelled 5–8 *P. taeda*, age 14 years, from Crown Land Beard, Compartment 3.

Group 3. Logs labelled 9–12 *P. caribaea*, age 22 years, from Crown Land Beard, Compartment 2.

Group 4. Logs labelled 13–16 *P. caribaea*, age 14 years, from Crown Land Beard, Compartment 3.

Group 5. Logs labelled 17–20 *P. sinensis*, age about 30 years, from Crown Land Montille, Compartment 2.

The Royal Botanic Gardens, Kew, having examined the botanical specimens, supplied the following identifications:

Groups 1 and 2, confirmed as *P. taeda*.

Groups 3 and 4, identified as *P. elliottii*, not *P. caribaea*.

Group 5, identified as *P. tabuliformis* Carr. var. *densata* (Masters) Rehd., not *P. sinensis*. Synonyms of this name include *P. densata* and *P. sinensis* var. *densata*.

Throughout this report the identifications furnished by Kew have been used.

In a report on *P. caribaea** it was mentioned that, while the vernacular name 'slash pine' is used for both *P. elliottii* and *P. caribaea*, the pulping properties of these two species are not identical. It was considered that the present investigation would yield further data on the pulping characteristics of both these and other species when grown in different habitats. It transpired, however, that the timber which was thought to be *P. caribaea* was eventually identified as *P. elliottii*. Nevertheless, useful data on the pulping characteristics of both *P. elliottii* and the other species have been obtained for comparison with those previously reported for these timbers in their native and other habitats.

P. taeda (the loblolly pine) is a well known, commercially used pulpwood in the United States, where it is included in one of the groups

* *Trop. Sci.*, 1959, **I**, No. 1, 22-40.

known as the 'Southern Pines'. *P. tabuliformis* var. *densata* (as the synonym *P. sinensis* suggests) is a native of China and North West Asia but it is one of the *Pinus* species which is often plantation grown elsewhere.

Sampling

Two logs from each group were used in the pulping trials, since it was considered that this procedure would, in the first instance, yield sufficient information to detect any gross differences within and between species. The logs selected for this purpose were:

Group 1	logs 1 and 2.
Group 2	logs 5 and 8.
Group 3	logs 11 and 12.
Group 4	logs 14 and 16.
Group 5	logs 17 and 19.

Discs two inches thick were removed from each end (i.e., the ends treated with Lignox) of these logs and discarded. The logs were then de-barked and sawn into billets of four inch square cross-section and converted into chips in a two-knife mechanical disc chipper. The chips from each log within a group were mixed in equal parts by weight and the resulting mixture used for the chemical analyses and pulping trials.

Chemical Examination

The mixed chips of each group were ground for analysis to pass a B.S.44 mesh sieve and be retained on a B.S.60 mesh sieve. The results of the chemical analyses of the ground material are given in Table II.

Physical Examination

The apparent density of the samples was determined according to the method of the American Technical Association of the Pulp and Paper Industry, T.18m.–50 and the results are given in Table I.

Pulping Trials

Pulping trials were carried out by the sulphate process, which consists, essentially, of cooking the chips in a solution of sodium hydroxide and sodium sulphide. They were performed in a small, stationary, electrically-heated, stainless steel vessel of about 1½ litres capacity. At the end of the cooking time, the digester was allowed to cool to 100°C. before opening. The cooking conditions were controlled to give a pulp with a *Tappi* Permanganate Number of about 25. (*Tappi* Standard Method T.214m.–42.) Data for these trials are given in Table III.

Pulp Evaluation and Beating Effect

Standard sheets were made from all the pulps, using the British Standard Sheet Machine according to the method described in the Second Report of the Pulp Evaluation Committee of the Paper Makers' Association.

The pulps were evaluated for beating effect in the Lampen mill and the results were interpolated to a Canadian Standard Freeness of 300. These beating trials were carried out according to the Tentative Standard

Method in the above report, except that the beating times were arranged so that the results could be interpolated to a Canadian Standard Freeness of 300. It should be mentioned that there was a tendency for the ball to 'ride' during these trials and when this occurred the mill was stopped and re-started.

In the course of sheet making by the Standard Method, no difficulty was experienced with any pulps from *Pinus taeda* and *P. elliottii* nor with the beaten pulps from *P. tabuliformis* var. *densata*. The unbeaten pulp from the last species, however, proved impossible to couch from the wire in the normal way. Consequently, an excess couching pressure was used with this pulp and some of the sheets were peeled from the wire by hand instead of being properly couched off on the blotter.

Prior to testing, the sheets were conditioned at a relative humidity of 65 per cent. and a temperature of 70°F. Evaluation was carried out in accordance with the official methods of the Paper Makers' Association.

The results of the unbeaten pulp evaluation are given in Table IV and those for the beaten pulps in Table V. Table V also includes, for comparison purposes, the following additional strength data for pulps also beaten to a C.S.F. of 300:

(i) *P. elliottii* timber obtained from the United States Department of Agriculture, Southeastern Forest Experimental Station, and pulped at this Institute;

(ii) *P. caribaea* timbers obtained from the Conservator of Forests, British Honduras, and pulped at this Institute;

(iii) Average strength data for commercial 'Southern Pine' pulps from the U.S.A. published by the late L. G. S. Hebbs, 'Recently developed sources of cellulose', *J. Soc. Dy. Col.*, 1939, **55**, 554, and for similar material in 1957 from a private communication in August, 1958.

P. taeda (loblolly pine) and *P. elliottii* (slash pine) are two of the species which are normally included (with others) in the general term 'Southern Pines'. Briefly, in comparison with Scandinavian kraft pulps at equal freeness, the typical 'Southern Pine' pulp characteristics are the retention of a high tearing strength together with comparatively low burst and tensile strength after relatively short beating times. The high bulk of the paper produced from them is also characteristic of these pulps and is accentuated in the case of unbeaten pulp.

Tables IV and V show that, with the exception of *P. tabuliformis* var. *densata*, the Mauritius pine pulps in general show these typical 'Southern Pine' characteristics.

P. tabuliformis var. *densata* and *P. caribaea* from British Honduras show rather different characteristics. In these pulps the 'Southern Pine' characteristics are over accentuated but it is considered that the results obtained for these species should be treated with some reserve in view of the beating and sheet making difficulties experienced with these pulps.

However, a comparison of the figures supplied by L. G. S. Hebbs for commercial 'Southern Pine' pulp in 1939 and 1957, shows a slight tendency for these pulps to have lower tensile but higher tearing strengths than formerly. This is probably due to changes in production and timber

blends and results in the more modern pulps having characteristics approaching nearer to those of *P. caribaea*.

Conclusions

The results of the pulping examination of these samples indicate that, with the exception of *P. tabuliformis* var. *densata*, they yield pulps very similar to those obtained by the Tropical Products Institute for *P. elliottii* and by other laboratories for 'Southern Pines' from the United States.

In many respects the pulps obtained from *P. tabuliformis* var. *densata* yield very similar results to those obtained from *P. caribaea* from British Honduras, especially with respect to the sheet forming difficulties and to the beating characteristics.

Despite the vernacular name of 'slash pine' often given to *P. caribaea*, neither this species nor *P. tabuliformis* var. *densata* normally form part of the commercially classified group of species known as 'Southern Pines'.

It is considered, however, that if *P. tabuliformis* var. *densata* were used as a minor component in admixture with *P. elliottii* and *P. taeda* the resulting pulp would not be significantly different from average commercial 'Southern Pine' pulp.

Acknowledgments

The authors wish to acknowledge permission granted by Messrs. Cross and Bevan to publish data on commercial pulp evaluation tests carried out in their laboratories.

Table I

Pinus Species from Mauritius

Apparent Density expressed as $\frac{\text{Oven-dry weight*}}{\text{Green (soaked) volume}}$		
Sample	g. per cc.	lb. per cu. ft.
P. taeda log 1 . . 25 years	0·40	25·0
P. taeda log 8 . . 14 years	0·45	28·0
P. elliottii log 12 . . 22 years	0·58	36·2
P. elliottii log 16 . . 14 years	0·52	32·4
P. tabuliformis var. *densata* 30 years log 19	0·65	40·6

The factor 62·4 was used to convert C.G.S. units to lb. per cu. ft.

* *Tappi* Standard Method T.18m.–50.

TABLE II

PINUS SPECIES FROM MAURITIUS

Chemical Analyses *

Sample	Group 1 *P. taeda* 25 years old	Group 2 *P. taeda* 14 years old	Group 3 *P. elliottii* 22 years old	Group 4 *P. elliottii* 14 years old	Group 5 *P. tabuliformis* var. *densata* 30 years old
Moisture, per cent.	7·5	5·0	5·6	6·8	5·5
Ash, per cent.†	0·28	0·31	0·23	0·23	0·19
Alcohol-Benzene Extractives, per cent.†	1·0	1·9	1·1	1·4	1·0
Holocellulose, per cent.‡ . .	68·8	63·7	70·3	72·5	72·4
Pentosans, per cent.† . . .	10·7	12·3	10·9	11·4	8·6

* All results, except moisture, expressed on oven-dry material.

† Carried out according to the appropriate standard method of the American Technical Association of the Pulp and Paper Industry. (TAPPI.)

‡ Determined by the method of Wise, Murphy and D'Addieco (*Paper Trade J.*, 1946, **122**, No. 2, 35).

TABLE III

PINUS SPECIES FROM MAURITIUS

Sulphate Process. Digestion Data

Cook Number	P2K25	P2K29	P2K26	P2K30	P2K27
Sample	Group 1 *P. taeda* 25 years	Group 2 *P. taeda* 14 years	Group 3 *P. elliottii* 22 years	Group 4 *P. elliottii* 14 years	Group 5 *P. tabuliformis var. densata* 30 years
Active Alkali as Na_2O on oven-dry raw material, per cent.*	17·5	17·5	17·5	17·5	17·5
Sulphidity, per cent.†	25	25	25	25	25
Liquor to oven-dry raw material ratio	3·75 : 1	3·75 : 1	3·75 : 1	3·75 : 1	3·75 : 1
Maximum Temperature, °C.	170	170	170	170	170
Time to reach maximum temperature, hour . . .	2	2	2	2	2
Time at maximum temperature, hour	2	2	2	2	2
Consumption of active alkali on oven-dry raw material, per cent.	14·5	12·6	15·5	12·7	13·1
Yield of Unbleached Pulp — Screened pulp, per cent. . . .	51·1	45·7	46·0	40·1	40·2
Screenings, per cent. . . .	2·5	3·5	1·0	1·0	2·0
Total, per cent. . . .	53·6	49·2	47·0	41·1	42·2
Permanganate Number (TAPPI)	25·0	27·0	24·7	23·6	27·0

* Active alkali = $NaOH + Na_2S$ expressed as Na_2O.

† Sulphidity = $\frac{Na_2S \times 100}{NaOH + Na_2S}$ Sodium compounds expressed as Na_2O.

Note: Digester took approximately 1 hour to cool to 100°C. before opening.

TABLE IV

PINUS SPECIES FROM MAURITIUS

Sulphate Process. Unbleached, Unbeaten, Pulp Evaluation

Sample	Group 1 *P. taeda* 25 years	Group 2 *P. taeda* 14 years	Group 3 *P. elliottii* 22 years	Group 4 *P. elliottii* 14 years	Group 5* *P. tabuliformis* var. *densata* 30 years
Cook Number	P2K25	P2K29	P2K26	P2K30	P2K27
Bulk	2·28	2·04	2·07	2·28	2·57
Burst Factor	24·0	27·6	22·6	17·7	10·9
Breaking Length, metres	4080	3448	2980	3043	2296
Tear Factor	150	170	153	133	143
Double Folds, Kohler-Molin, 600 g.	1016	835	143	68	19
Drainage Time, sec.	4·3	4·5	4·4	4·2	4·3
Canadian Standard Freeness	740	740	750	750	760

* It was not possible to produce sheets from *P. tabuliformis* var. *densata* by the standard procedure.

Table V

Pinus Species from Mauritius

Sulphate Process. Unbleached, Beaten, Pulp Evaluation at 300 C.S.F. Lampen Mill. *

Sample	Group 1 *P. taeda* 25 years	Group 2 *P. taeda* 14 years	Group 3 *P. elliottii* 22 years	Group 4 *P. elliottii* 14 years	Group 5 *P. tabuliformis var. densata* 30 years	† *P. elliottii* 12 years	‡ *P. caribaea* 24 years	‡ *P. caribaea* 12 years	§ 'Southern Pines' Pulp Hebbs 1939	§ 'Southern Pines' Pulp Hebbs 1957
Cook Number	P2K25	P2K29	P2K26	P2K30	P2K27	P2K20	P2K17	P2K16		
Beating Time, min.	48·5	58	59	60·5	40	50	37	49·5	52	55
Bulk	1·52	1·50	1·52	1·59	1·56	1·47	1·54	1·50	1·50	—
Burst Factor	54·5	36·0	30·5	43·0	44·4	43·2	50·0	32·2	58	61
Breaking Length, metres	8200	5600	4750	6200	6403	6672	7770	5380	8810	8170
Tear Factor	131	120	115	150	182	139	193	132	115	134
Double Folds, Kohler-Molin, 600 g.	5400	1000	300	2950	5422	1560	4600	800	—	—
Drainage Time, sec.	7·2	5·5	5·5	5·5	6·7	5·6	7·5	5·2	—	—

* With the exception of *P. tabuliformis* var. *densata*, all the results on this table have been interpolated to a CSF of 300.
† Sample obtained from the U.S. Department of Agriculture (Southeastern Forest Experimental Station).
‡ Samples obtained from the Conservator of Forests, British Honduras.
§ Results obtained from average samples of commercial, unbleached 'Southern Pine' pulps and published by L. G. S. Hebbs, 'Recently Developed Sources of Cellulose', *J. Soc. Dy. Col.*, 1939, **55**, 554 and from a private communication August 1958.

Dates from the Eastern Aden Protectorate

By P. C. Crowther and E. H. G. Smith

Introduction

Samples representing five varieties of dried dates from the Hadhramaut, Eastern Aden Protectorate, form the subject of this report. A small commercial consignment of one variety, *Hamra*, had been despatched to a London importer for trials to determine the suitability of that variety for the United Kingdom market. At the same time samples of four other varieties of Hadhrami dates were submitted by the Agricultural Officer, Sai'un for preliminary commercial assessment. An analysis of samples of all varieties was requested to provide information regarding the composition of dates produced in the area.

Description of Samples

The five varieties were as follows:

Variety	*Colour*
1. *Hamra*	Purple-brown to black.
2. *Suryea* (*Seryia*)	Purple-brown.
3. *Medini* (*Madeni*)	Black.
4. *Gizaz* (*Jezaz*)	Dark-brown with some light brown (colour affected by 'shelly' condition).
5. *Migraf* (*Mejraf*)	Light amber, some dates had light-coloured flesh at the stalk ends of the fruit.

Insect infestation was observed in the dates on arrival and the samples were fumigated with methyl bromide at the Pest Infestation Laboratory prior to analysis.

Method of Examination

After removing the stones the following chemical determinations were carried out on dates according to the methods given in the *Official Methods of Analysis of the Association of Official Agricultural Chemists*, 8th Edition, 1955: Ash content, method 29·12; protein, method 20·39; calcium, method 6·11; magnesium, method 6·13; sulphur, method 6·58; chloride, method (29·12) and then determined potentiometrically. Iron was determined colorimetrically using thioglycollic acid. ('Colorimetric Methods of Analysis', by Snell and Snell, 1957, **II**, p. 319.) Phosphate was also determined colorimetrically using the method given in the *Journal of the Science of Food and Agriculture*, 1950, **1**, 172-73. The potassium and sodium were determined by flame photometry using an 'Eel' flame photometer. Sugar and copper were determined by the methods given in the text-book *Laboratory Inspection of Canned and Bottled Foods*, by D. Dickinson and P. Goose, pages 120 and 106, respectively. Moisture was determined by the method of F. G. H. Tate and L. A. Warren, *Analyst*, 1936, **61**, 267.

Results of Examination

The results of the analysis (chemical) and (physical) are given in Tables I, and II, respectively.

Comments

The results of this examination indicate that there are no important differences in composition between dates grown in the Hadhramaut, Eastern Aden Protectorate, and those produced elsewhere. As will be noted in Table I, slight differences are apparent, but these are of little significance. The potassium, chloride and copper contents are slightly higher, and the phosphorus, nitrogen (protein) and sulphur contents are slightly lower than the figures quoted for comparative purposes. Figures published for the composition of Moroccan dates* closely follow those determined for the samples of Hadhrami dates except that the calcium content is approximately twice as high. This is probably due to the calcareous nature of the soils on which dates are grown in Morocco. The relatively high chloride contents found in the Hadhrami samples may be due to cultural conditions, since it is known that certain soils in the Protectorate are saline.

With regard to the physical examination of the date samples given in Table II, three varieties, *Suryea*, *Gizaz* and *Migraf* have similar characteristics with respect to the average weight of fruit and seeds. The varieties *Hamra* and *Medini* have smaller fruits and seeds, although the ratios of average weight of seed to whole fruit are similar for all five varieties.

The dates of the variety *Migraf* were judged to have the best flavour

Commercial Assessment

Samples of the varieties *Suryea*, *Medini*, *Gizaz* and *Migraf* were assessed by the London importer handling the experimental consignment of *Hamra* dates. This firm's report was submitted separately but the general conclusions may be summarized briefly as follows. Dates of the *Hamra* variety were tested for the repacking trade but although of satisfactory quality were found to be too dark in colour for general use. The opinion was expressed that this variety would only sell freely in the United Kingdom if dates from established commercial sources were in short supply. Both the *Suryea* and *Medini* varieties were judged to resemble closely the *Hamra* date and would not appear to merit further consideration. The lighter colour of the *Gizaz* dates rendered this variety more suited to United Kingdom market requirements but the sample arrived in a dry and shelly condition; this may be a varietal characteristic. On the other hand dates of the *Migraf* variety were described as extremely good in appearance, with an excellent golden colour, and of the type that should command a ready sale in the United Kingdom both for retail and repacking provided commercial quantities were available at a reasonable price.

* *Fruits*, 1954, **9**, No. 10, 443-49.

Production Position

At the present time, less than six per cent. of the Hadhramaut consist of the variety, *Migraf*, and since this variety is in considerable demand for local consumption, the possibilities of export developments are very limited.

Table I

Results of the Examination (Chemical)

Expressed on the samples as received

Variety	*Hamra*	*Suryea (Seryia)*	*Medini (Madeni)*	*Gizaz (Jezaz)*	*Migraf (Mejraf)*	*Dates**
Moisture per cent.	13·1	11·9	10·0	13·8	12·6	14·6
Protein per cent. (Nitrogen × 6·25)	2·06	1·62	1·44	1·75	1·38	2·0
Sugar as invert per cent.	68·5	63·8	66·3	64·7	64·1	63·9
Ash per cent.	2·05	1·93	2·15	1·90	1·86	—
Potassium per cent. as K.	1·01	0·84	0·91	0·94	1·00	0·754
Calcium as Ca per cent.	0·060	0·066	0·064	0·041	0·046	0·0679
Magnesium as Mg. per cent.	0·072	0·077	0·057	0·051	0·054	0·0585
Phosphorus as P. per cent.	0·054	0·048	0·050	0·032	0·039	0·0638
Sulphur as S per cent.	0·046	0·038	0·038	0·039	0·031	0·051
Chloride as Cl per cent.	0·37	0·35	0·48	0·38	0·39	0·29
Sodium as Na per cent.	0·008	0·004	0·005	0·006	0·004	0·0048
Copper mg. per 100g.	0·4	0·4	0·5	0·3	0·4	0·21
Iron mg. per 100 g.	1·88	1·48	2·40	2·18	1·63	1·61
pH	6·10	6·15	6·50	6·20	6·10	—

* "Chemical Composition of Foods" by R. A. McCance and E. M. Widdowson, Special Report Series, No. 235 of the Medical Research Council. (H.M.S.O., 1940)

Table II

Results of Examination (Physical)

Variety	*Hamra*	*Suryea (Seryia)*	*Medini (Madeni)*	*Gizaz (Jezaz)*	*Migraf (Mejraf)*
Average size of fruit in mm.					
Length	30·0	35·9	32·0	32·2	33·7
Diameter	14·8	16·0	14·6	16·0	16·3
Average weight of whole fruit in g.	6·06	7·01	5·15	6·77	6·89
Average weight of seed in g.	0·80	0·96	0·71	0·96	0·97
Relation of average weight of seed to whole fruit per cent.	13·2	13·6	13·8	14·1	14·0

Patchouli from the Seychelles

By W. S. Matthews and G. B. Pickering

A sample of dried patchouli leaves was submitted in recent months by the Director of Agriculture, Seychelles. It was stated that the leaves had been collected from plants grown from cuttings imported from Singapore. The cuttings had been imported with a view to determining whether the difference in quality between the Seychelles and Singapore oils could be due to varietal or other (climatic and soil) factors.

The leaves were to be distilled at the Institute in order to evaluate the quality of the oil obtained from this new planting when the material was distilled under the best conditions.

A sample of oil, distilled in the Seychelles from dried leaves was also submitted for examination, the yield being 42 litres of oil from a ton of dried leaves.

Examination

The leaves were in good condition being free from mildew and insect damage. A small representative portion of the leaves was used for moisture determination by the vapour entrainment method using the Dean and Stark apparatus specified in B.S. 756 : 1952. The remainder, amounting to 58 lb., was distilled in a stainless steel still equipped for cohobation and fitted with a metal grid to support the leaves above the steam sparge and heating coils. Distillation was carried out by direct steam in the first instance, the aqueous distillates being returned to the still. When sufficient distillate had been returned to cover the heating coils in the still the distillation was continued using the coils, and cohobating the distillation waters, until the leaves were exhausted of oil.

The yield of oil on the leaves as received (containing 11·3 per cent. volume/weight of moisture) was 3·73 per cent. weight/weight corresponding to 4·22 per cent. weight/weight on the moisture-free leaves.

The oil obtained was yellow in colour with a characteristic patchouli odour. Before analysis it was filtered through paper. The results of analysis by the methods of B.S. 2073 : 1953 are shown in the accompanying table, together with those of the sample of oil distilled in the Seychelles. The standards of B.S. 2999/10 for Oil of Patchouli, East Indian and B.S. 2999/11 for Oil of Patchouli, Seychelles and African are also shown for comparison. In addition, the ester value after acetylation (which is not included in the British Standards) is shown, together with the corresponding values for Seychelles and East Indian oils (see page 96).

It will be seen from these results that the constants of the two oils examined here are in fairly close agreement and conform to the requirements of the British Standard for Seychelles oils. However, the figures obtained for the weight per ml. of both oils is just below the minimum specified for East Indian oils and, for the ester value after acetylation, much lower than the minimum recorded for this type of oil.

The oil distilled at the Institute was examined by gas chromatography in comparison with a trade sample of patchouli oil of Malayan origin which was stated to be of good quality. No significant differences could be observed between the chromatograms which were run on columns of polypropylene sebacate at temperatures of 100°C. and 150°C. using the Argon chromatograph.

Commercial Valuation

Samples of the oil distilled here from the leaves were submitted for valuation to four firms, represented on the Institute's Consultative Committee on Essential Oils. They reported on the oil as follows:

Firm A

"I have now had an opportunity of making a careful comparison with the normal qualities of Indonesian and Penang Patchouli oils, which come on to this market.

I have also compared with it a sample of Seychelles Patchouli, which we ourselves imported and, in my opinion, the odour of your oil is quite different and I do not believe it would sell very readily.

I have not had an offer of Seychelles Patchouli below 40*s*. per lb. for some time and, unfortunately, this is well above the price of the Penang and Indonesian oils, which can be purchased to-day around 31*s*. to 35*s*. per lb. C.I.F. The lowest price at which Seychelles have offered over the past year or so, has been 30*s*. per lb., and at that time, it was possible to buy from Penang at 20*s*. to 21*s*. per lb. As a consequence of this wide difference in price and because of the difference in odour and quality, the demand for the Seychelles oil is almost negligible."

Firm B

"We very largely agree with your own assessment of this oil. It is similar in character to Seychelles Oil but is rather better than that usually obtained from the Seychelles. This, of course, may be due to the quality of your apparatus and the care with which you distil it. We see no reason why this oil should not be perfectly saleable with the market value being around 40*s*. lb."

Firm C

"We find that the initial odour of this oil is very strong but unlike Patchouli Oil as we know it because of certain bynotes.

On airing the odour becomes much more pleasant but tends to lose all its strength and character.

The sample was submitted to the Perfumery Department who consider that it had not the true Patchouli odour."

Firm D

"In my opinion this oil is of excellent quality and should prove extremely useful to the trade. It is, however, appreciably different from both the normal Seychelles and the Singapore oils. It strikes me

as being much fuller than either of these oils and I would certainly prefer to use an oil of this type. It does appear, however, that its use would give noticeably different odours in finished perfumes. It could therefore only be a matter of a perfumer's opinion as to whether it is better or not than existing oils.

I do repeat that, in my opinion, this is a better oil than we normally use, and I would certainly recommend that this be put into production, at any rate on a limited scale, and sampled around the market.

As you know perfumers are extremely conservative about changes in raw materials which result in different odours in the finished products so that the success of such an oil would largely rest on the opinion of the perfumers."

Remarks

The importation of planting material from Singapore to the Seychelles has not so far resulted in the production of an oil of quite the East Indian type. Assuming this material to have been obtained from a reliable source, known to produce an oil of good quality in its original habitat, there are several factors which could be responsible for this difference. It might be a question of cultivation and harvesting, e.g., planting material which has been cut prematurely and is too young gives an inferior oil. Factors of climate and, more particularly, soil, might be involved. The leaves may not have aged sufficiently before distillation and the oil itself may well improve on ageing as is generally the case with Patchouli oils.

On account of the differences from the East Indian type, the more conservative trade opinion is not inclined towards this oil.

Nevertheless, other trade opinion generally favours the oil distilled at the Institute from Singapore planting material as being of better quality than the oils normally received from the Seychelles and considers that it would have a steady market if regular supplies of a consistent quality could be maintained.

Analytical Constants of Patchouli Oils

	Samples of oil from leaves of plants imported originally from Singapore		Oil of Patchouli, Seychelles and African, B.S. 2999/11	Oil of Patchouli, East Indian, B.S. 2999/10
	Distilled at T.P.I.	Distilled in Seychelles		
Weight per ml. at 20°C., g.	0·9507	0·9519	0·945 to 0·990	0·952 to 0·980
Optical rotation, α_D 20°C.	−48·6° (at 22·5°C.)	−48·68° (at 21·5°C.)	−40° to −68°	−47° to −60°
Refractive index, n_D 20°C.	1·5077	1·5080	1·505 to 1·510	1·506 to 1·512
Solubility in 90 per cent. v/v alcohol at 20°C.	Soluble in 10 vol. with slight opalescence	Soluble in 9·5 vol.	Soluble in 10 vol.	Soluble in 10 vol.
Acid Value, mg. KOH/g. oil . . .	0·3	1·2	Not more than 3·0	Not more than 4·0
Ester Value, mg. KOH/g. oil . . .	0·3	1·1	Not more than 9·0	Not more than 10·0
Ester Value after acetylation, mg. KOH/g. acetylated oil	9·6	9·3	8·0 to 22·0*	16·8 to 21·5†

* Details of tests adopted in ascertaining "Standard Quality" Essential Oils (Seychelles Department of Agriculture) (Letter from the Governor, 4th May, 1937).

† Guenther "The Essential Oils", (New York, London D. Van Nostrand & Co. 1949) Volume III, p. 570.

Destructively Distilled Turpentine from Cyprus

By Miss E. E. L. Edwards and G. E. Howard

This sample of destructively distilled turpentine, which had been prepared from the wood of *Pinus halepensis* var. *brutia*, was sent to the Institute by the Conservator of Forests, Cyprus.

Description of Sample

The sample consisted of 450 ml. of a mobile oil which was very slightly yellow in colour and contained a little water.

Examination

The analytical constants were determined in accordance with the methods specified in the British Standard for Turpentine type 2 (B.S. 290 : 1936) and by the American Society for Testing Materials (A.S.T.M. D 233-51). The results of these tests are shown in the accompanying table alongside the ranges of values allowed by these two standards.

The sample was also examined by gas chromatography, and the chief constituent (α–pinene) was identified and estimated. The other components were tentatively identified as camphene, β–pinene, $\triangle^3$–carene and limonene.

Trade Valuation

A sample of the turpentine was submitted to the principal of a leading London firm of importers of gum rosin and turpentine who reported as follows:

> 'The sample of Cyprian turpentine which you forwarded to me appears to be quite good, and from a quality point of view should compete well with Swedish sulphate turpentine.
>
> Apart from the usual reluctance of consumers to try out new products, I do not think there will be any difficulty in marketing this turpentine in the United Kingdom, but it will be necessary to compete with the Swedish sulphate turpentine which is being offered here in free drums at £60 per ton, c.i.f. London, exclusive of duty. If the Forestry Department could meet this price, I should be perfectly willing to endeavour to find outlets for the material.'

Remarks

The turpentine satisfies both the British Standard and the American for this grade, except for a very slight divergence from the range for non-volatile residue in the case of the former, and from specific gravity in the case of the latter. These divergencies are not greatly significant.

It is clear from the trade valuation that the turpentine would be marketable in the United Kingdom if it could compete with the keen price of Swedish sulphate turpentine which, it must be remembered, is a cheap by-product of the wood pulping industry.

Analytical Constants of Destructively Distilled Turpentine from Cyprus

	Present Sample	B.S. Specification	A.S.T.M. Specification
Specific gravity 15·5°/15·5°C.	0·8677	0·859 to 0·875	0·850 to 0·865
Refractive index n_D20	1·4701	1·463 to 1·483	1·463 to 1·483
Optical rotation $\alpha_D23°C.$	−26·79°	—	—
Non-volatile residue (per cent.)			
B.S.	2·64	not more than 2·0	—
A.S.T.M.	3·95	—	—
Polymerisation residue (per cent.)			
B.S.	8·0	not more than 16·0	—
A.S.T.M.	3·40	—	not more than 2·0
Refractive index of residue			
B.S.	1·4997	not lower than 1·480	—
A.S.T.M.	1·5004	—	not lower than 1·480
Distilling range			
Initial boiling point	150°C.	—	150°C. to 157°C.
Distilling below 150°C. (per cent.)	nil	not more than 1	—
Distilling below 170°C. (per cent.)	90	not less than 70	not less than 60
Distilling below 180°C. (per cent.)	94	not less than 90	not less than 90
Flash point	90·5°F.	not less than 90°F.	—
α-pinene content (per cent.)	64·0	—	—

Exports of Essential Oils from the British Colonies for the Years 1953-58

Compiled from the annual trade reports issued by the Governments of the Colonies and from Barclays Bank Overseas Survey

Quantities in lb. with value in £ sterling

	1953	1954	1955	1956	1957	1958
EAST AFRICA						
Kenya						
Geranium Oil	4,448	6,897	6,014	4,580	2,188	721
	£17,742	£18,072	£14,990	£12,000	£7,869	£2,647
Cedarwood Oil	66,852	53,538	100,060	65,062	103,263	64,600
	£9,428	£9,691	£23,548	£11,592	£18,270	£11,786
Other Essential Oils	14,597	8,880	7,448	12,208	12,268	15,078
	£2,944	£2,133	£2,774	£6,136	£6,548	£5,674
Uganda						
Geranium Oil	220	—	—	—	—	—
	£347	—	—	—	—	—
Other Essential Oils	—	—	272	—	—	—
	—	—	£102	—	—	—
Tanganyika						
Lemongrass Oil	408	—	—	—	—	—
	£117	—	—	—	—	—
Bitter Orange Oil	7,416	5,733	6,300	7,272	8,173	7,516
	£6,162	£4,430	£4,725	£5,103	£6,202	£5,639
Geranium Oil	—	—	—	375	600	—
	—	—	—	£978	£1,910	—
Other Essential Oils	330	—	779	1,257	1,023	1,287
	£253	—	£1,366	£1,689	£1,422	£1,365
Zanzibar						
Clove Stem Oil (a)	178,815	258,832	191,211	179,939	215,210	205,351
	£99,319	£143,850	£106,844	£90,757	£85,779	£68,484
INDIAN OCEAN						
Seychelles						
Cinnamon Leaf Oil	218,692	218,233	174,090	208,954	129,037	183,680
	£78,449	£104,115	£75,825	£67,460	£41,648	£43,652
Patchouli Oil	4,440	602	962	1,175	2,646	227
	£8,558	£1,389	£2,587	£2,042	£3,784	£312
Eucalyptus Oil (b)	46	—	—	—	99	(c)
	£38	—	—	—	£23	
Clove Leaf Oil	820	—	—	—	—	—
	£296	—	—	—	—	—
BRITISH WEST INDIES						
Jamaica						
Grapefruit Oil	6,997	5,133	6,197	5,100	1,975	4,075
	£5,965	£4,099	£4,146	£3,656	£1,244	£2,192
Lemon Oil	1,300	1,100	377	750	1,475	—
	£1,282	£975	£328	£617	£1,340	—
Lime Oil	44,446	31,571	41,000	50,796	38,350	51,115
	£81,789	£55,243	£53,679	£73,838	£66,022	£98,379
Orange Oil	103,060	144,643	121,950	124,966	104,080	109,529
	£57,750	£57,536	£45,220	£53,319	£46,939	£59,846

For earlier statistics, see *Bull. imp. Inst.*, 1948, **46**, 159; also *Colon. Pl. Anim. Prod.*, 1953, **3**, 28; 1954, **4**, 24; 1955, **5**, 211; also *Trop. Sci.*, 1959, **1**, 13. In a few cases, the figures previously published have been revised in the light of more recent information.

(a) Stated to be Clove Bud and Stem Oil.

(b) *E. citriodora.*

(c) Information not available.

	1953	1954	1955	1956	1957	1958
BRITISH WEST INDIES						
Jamaica (*cont.*)						
Pimento Oil	95,859	83,838	91,919	62,909	35,920	60,432
	£66,558	£58,450	£67,133	£43,383	£20,995	£32,562
Other Essential Oils	830	725	—	—	—	—
	£718	£359	—	—	—	—
Trinidad and Tobago						
Lime Oil (Distilled)	22,103	6,807	5,408	13,547	6,537	7,756
	£46,428	£12,316	£8,180	£19,607	£13,284	£18,588
Lime Oil (Expressed)	490	—	96	622	—	—
	£968	—	£236	£781	—	—
Other Essential Oils	—	—	—	(c)	2	5
(not including turpentine)	—	—	—	—	£2	£3
British Honduras						
Grapefruit Oil	4,731	6,161	7,380	3,070	1,358	(c)
	£2,098	£3,115	£9,526	£5,110	£708	
Orange Oil	1,820	4,964	9,526	27,252	20,569	(c)
	£829	£1,173	£1,532	£4,875	£3,113	
Windward Islands						
Dominica						
Bay Oil	26,009	39,856	38,348	48,244	21,453	37,000
	£9,547	£15,321	£19,544	£25,600	£12,500	£21,042
Citronella Oil	(c)	(c)	2,612	(c)	(c)	(c)
	—	—	£1,507	—	—	
Grapefruit Oil	315	316	336	(c)	(c)	(c)
	£313	£313	£289	—	—	
Lime Oil (Distilled)	55,463	34,906	40,149	31,616	20,000	43,000
	£100,214	£68,006	£64,147	£53,700	£47,292	£112,083
Lime Oil (Ecuelled)	1,080	1,610	2,158	791	(c)	(c)
	£3,375	£4,316	£6,851	—	—	
Orange Oil (Sweet)	105	105				
	£101	£87	616	(c)	(c)	(c)
Orange Oil (Bitter)	848	—	£493			
	£644	—				
Essential Oil in solution in Lime Juice	16,287	1,521	3,300 (d)	(c)	(c)	(c)
	(c)	(c)	(c)	(c)	(c)	(c)
Grenada						
Lime Oil	7,068	10,270	3,631	460	1,356	1,751
	£13,057	£13,351	£5,407	605	£2,660	£4,352
Nutmeg Oil	10,260	4,050	6,570	2,385	—	315
	£9,760	£3,780	£7,301	£4,516	—	£1,734
St. Lucia						
Lime Oil (Distilled)	3,668	70	1,204	1,799	88	(c)
	£6,960	£99	£1,142	£2,348	£154	
Lime Oil (Ecuelled)	172	—	—	—	—	—
	£495	—	—	—	—	—
Leeward Islands						
Montserrat						
Lime Oil (Distilled)	(c)	61	—	(c)	(c)	(c)
	—	£124	—	—	—	
Lime Oil (Ecuelled)	699	248	85	85	(c)	(c)
	£1,632	£463	£150	£148	—	
British Guiana						
Lime Oil	8,529	—	1,598	1,179	300	1,395
	£15,830	—	£2,050	£2,349	£654	£4,046
Other Essential Oils	488	34	83	519	527	—
(not including turpentine)	£241	£24	£46	£246	£245	—

(c) Information not available.
(d) Lime oil content of top pulp lime juice exported estimated at 4 lb. of oil to 100 gal. of juice.

	1953	1954	1955	1956	1957	1958
MEDITERRANEAN						
Cyprus						
Almond Oil	5,824	—	—	1,792	—	—
	£1,067	—	—	£600	—	—
Aniseed Oil	112	224	—	—	—	—
	£60	£270	—	—	—	—
Citrus Oil	32,928	6,720	11,648	21,280	6,496	11,424
	£33,921	£7,143	£13,334	£29,839	£11,621	£10,297
Origamum Oil	—	672	3,808	—	—	—
	—	£345	£2,076	—	—	—
Other Essential Oils	336	2,912	(c)	224	(c)	224
	£284	£1,798	£1,478	£224	£79	£322

(c) Information not available.

Exports of Essential Oils from the Commonwealth Countries for the Years 1953-58

Compiled from the annual trade reports issued by the Governments of the Commonwealth countries and from Barclays Bank Overseas Survey

Quantities in lb. with value in £ sterling

	1953	1954	1955	1956	1957	1958
AUSTRALIA (a)						
Eucalyptus Oil	721,330	504,628	443,933	683,131	547,435	354,434
	£172,226	£131,010	£122,858	£219,230	£158,858	£105,188
Sandalwood Oil	—	3,057	(b)	(b)	(b)	(b)
	—	£5,986	—	—	—	—
Other Essential Oils	37,614	80,685	46,826	88,667	56,820	44,235
	£29,286	£23,283	£36,628	£68,932	£39,577	£47,193
CANADA						
Essential Oil	18,148	35,306	39,855	70,718	78,136	34,008
	£22,200	£34,080	£33,776	£53,389	£68,871	£26,539
CEYLON						
Cinnamon Bark Oil	921	979	1,941	2,574	2,429	1,849
	£6,020	£7,597	£17,922	£23,706	£24,633	£19,640
Cinnamon Leaf Oil	90,653	155,314	87,287	137,966	69,925	54,599
	£33,729	£68,751	£48,121	£42,345	£37,719	£26,696
Citronella Oil	1,409,315	1,390,020	1,576,490	1,332,144	1,325,171	1,145,747
	£208,090	£349,046	£506,264	£383,105	£312,095	£201,372
Other Essential Oils	—	—	—	—	50	—
	—	—	—	—	£611	—
INDIA (d)				(Apl.-Dec.)		
Sandalwood Oil	130,458	153,616	186,457	147,529	198,338	199,074
	£377,591	£429,961	£541,576	£531,053	£789,725	£690,327
Lemongrass Oil	839,569	1,247,106	1,732,882	1,672,573	3,053,535	2,776,572
	£293,783	£404,107	£995,047	£839,413	£1,174,959	£776,560
Palmarosa Oil	139,421	97,467	150,208	100,550	124,645	98,409
	£156,271	£98,028	£210,238	£163,961	£121,815	£72,152
Other Essential Oils	43,961	103,730	34,175	42,687	66,380	40,715
	£15,885	£18,249	£9,784	£22,975	£75,279	£27,200

(a) Years ended 30th June of that stated.
(b) Included, if any, with "Other Essential Oils".
(d) Years ended 31st March until 1955; 9 months—April-December in 1956, calendar years thereafter.

	1953	1954	1955	1956	1957	1958
ASIA						
Malaya including Singapore*						
Citronella Oil .	5,465	3,868	37,143	83,196	75,465	90,215
Exports (including re-exports) .	£1,060	£863	£16,926	£36,052	£24,620	£14,718
Imports . .	7,043	18,029	6,696	11,025	13,311	37,147
	£1,545	£7,731	£2,850	£3,792	£4,578	£5,495
Excess of Imports over Exports .	1,578	14,161	—	—	—	—
	£485	£6,868	—	—	—	—
Excess of Exports over Imports .	—	—	30,447	72,171	62,154	53,068
	—	—	£14,076	£32,260	£20,042	£9,223
Eucalyptus Oil .	4,040	7,163	6,061	6,279	5,369	6,069
Exports (including re-exports) .	£1,821	£3,083	£3,003	£2,839	£1,730	£2,044
Imports . .	13,652	25,393	16,935	30,139	36,127	20,755
	£4,664	£9,360	£7,439	£11,427	£10,199	£6,416
Excess of Imports over Exports .	9,612	18,230	10,875	23,860	30,758	14,686
	£2,843	£6,277	£4,436	£8,588	£8,469	£4,372
Patchouli Oil .	132,393	263,960	191,400	343,817	183,893	243,354
Exports (including re-exports) .	£247,096	£495,030	£344,147	£419,197	£218,517	£213,793
Imports . .	121,426	260,426	285,452	233,964	213,371	265,072
	£129,972	£314,858	£261,397	£212,712	£184,198	£204,709
Excess of Imports over Exports .	—	—	94,052	—	29,479	21,718
	—	—	—	—	—	—
Excess of Exports over Imports .	10,967	3,534	—	109,853	—	—
	£117,124	£180,172	£82,750	£206,485	£34,319	£9,084
Other Essential Oils (e)	21,218	73,222	57,056	49,277	146,480	74,088
Exports (including re-exports) .	£14,868	£70,571	£68,355	£70,303	£63,866	£81,046
Imports . .	65,289	72,484	90,319	105,553	78,209	117,479
	£55,399	£72,605	£83,352	£82,075	£67,960	£94,882
Excess of Imports over Exports .	44,071	—	33,263	56,276	68,280	43,391
	£40,531	£2,034	£14,997	£11,772	—	£13,836
Excess of Exports over Imports .	—	738	—	—	—	—
	—	—	—	—	£4,094	—

* Weights have been converted from gallons and are therefore approximate.
(e) Includes Cinnamon, Clove, Mace, Peppermint, and Sandalwood Oils.

Notes

The United Kingdom Market for Avocado Pears.—There is a limited market for avocado pears in the United Kingdom throughout the year. Supplies are obtained mainly from the Union of South Africa and the peak period for shipments from that country is during the months of April to September, when the fruit has to compete on the United Kingdom market with the wide range of berry and deciduous fruits then available. Madeira has been a traditional supplier of small quantities of avocado pears to this market during the winter months but fruit from this source does not withstand the journey well and generally arrives here in an inferior condition to many of the South African consignments. In recent years Israel has developed a small export trade of avocado pears to Northern European countries. Most of the fruit is consigned to the United Kingdom and, hitherto, it has been sent by air freight so that it usually arrives on the market in a very good condition. It is understood that producers in Israel are hoping to expand the trade and are carrying out experiments in sending the fruit by sea. The Israeli fruit is available for export from November through to May and thus has the advantage, compared with the bulk of South African shipments, that it has not to compete with soft fruits particularly strawberries, on this market. Since last year small, but increasing, supplies of avocados have also been received from California. The arrival of Californian fruit in the United Kingdom is noteworthy since exporters in that state are in a very competitive position should there be any further liberalization of trade between this country and the United States. Californian exporters have the advantage that they can send fruit at almost any time of the year and that the production and marketing of avocado pears for the American domestic market is already well organized. Much of the fruit is graded and shipped under advertized brand names such as 'Calavo'. In addition, superior transport facilities are available in the United States, compared with the Union of South Africa, where difficulties are encountered in obtaining quick refrigerated rail transport to the ports. For the United Kingdom market much of the Californian fruit is railed to New York and shipped from that port. Small consignments of avocado pears are also received from time to time on the United Kingdom market from the Canary Islands, the West Indies and recently from Brazil. Kenya also sends small quantities by air. However, an important factor for any intending new exporter is that regular consignments should be sent to this country if the trade is to become firmly established. Buyers here consider that it is far easier for an exporter to gain a good reputation on the market if regular consignments of reasonable size of good quality fruit are sent as against spasmodic large consignments.

The general opinion of the trade is that the market for avocado pears is extremely limited and is likely to become more competitive, although several people consider that the demand for the fruit is slowly increasing. However, it cannot be emphasized too strongly that avocado pears are very much a luxury fruit and are unknown to many of the British public. In an attempt to broaden outlets South African exporters have provided written suggestions on the best methods of eating the fruit.

The present consumption of avocado pears in the United Kingdom can only be estimated, since imports are not recorded separately in the trade returns. However, shipments from the Union of South Africa in recent years are estimated to have amounted to from 35,000 to 38,000 trays (approximate weight of a tray 12 lb.), with possibly some 1,500 trays from Israel. It has been suggested that this market could absorb about 60,000 trays per annum at the present price level, but any increase in consumption is likely to be very slow owing to the relatively high prices the fruit fetches and to the fact that it is unfamiliar to many people. At present the trade consider that outlets are limited and that the market is extremely sensitive. Any small excess of supplies usually results in a considerable drop in prices below that which exporters consider to be a remunerative level.

Some six years ago the Senior Trade Commissioner in London for the Union of South Africa estimated that about 3,000 trays of fruit per week were sufficient to meet the United Kingdom requirements, although it seems doubtful whether a trade on this scale could be maintained throughout the year. In recent years good-quality fruit has usually fetched between 1*s.* to 3*s.* 6*d.* on the London wholesale market depending upon its size and the supplies available at any particular period.

Avocado pears are a difficult fruit to transport successfully over long distances. Although there are many different varieties of avocado pears, some do not retain their quality when shipped or are not of sufficiently high quality initially to compete in overseas export markets. The Fuerte variety, with its characteristic nutty flavour, is considered by many growers to produce a fruit very suitable for marketing commercially and it is now widely grown. The bulk of the avocado pears received on the United Kingdom market are of the Fuerte variety since the Union of South Africa, Israel and California all send this fruit here. In addition, the Union also sends small quantities of the varieties Ryan and Edranol during October, November and December.

Buyers favour a medium-sized fruit of from 4 to 6 in. in length with a green or deep-green colour. The fruit should arrive here slightly under-ripe so that it has as long a shelf life as possible. The fruit should also have a thick enough skin to protect the flesh during shipment yet thin enough to permit the degree of ripeness to be easily determined by touch. The flesh should have a buttery texture and be free from fibres and reasonably thick. The oil content is a factor of quality in so far as if it is high many people consider the fruit to be too rich and to have a disagreeable oily flavour. The oil content is an index of the degree of maturity of the fruit and in California avocado pears are not considered sufficiently mature for harvesting until their oil content is above 8 per cent. In fact, first grade fruit of the Fuerte variety must have a minimum oil content of at least 12 per cent. South African producers have found that for export to the United Kingdom fruit with an oil content of between 12 and 18 per cent. is the most satisfactory.

For export avocado pears are harvested firm, some growers recommend that the fruit should be slightly immature. It should be picked with hand clippers and the stem cut as close as possible to the fruit. After picking, it should be handled very carefully to avoid bruising and cooled promptly to remove field heat. The fruits should be graded carefully and all those showing signs of bruising, wind or scale injury should be removed. Only those of uniform size should be packed in the same crate or box. In the Union of South Africa only fruits with a diameter of between $2\frac{1}{2}$ and $3\frac{1}{2}$ in. are considered suitable for export.

Buyers in the United Kingdom prefer avocado pears to be packed in single layers in trays of approximately 12 in. × 18 in. × 5 in. and containing counts of 12, 14, or 16. The fruits are usually wrapped individually in cellophane, or tissue paper, or polythene and packed tightly in layers of soft wood wool. Some South African exporters seal the stem end of the fruits with paraffin wax and place them in polythene bags before packing in an attempt to reduce wastage. Bags made of a thin grade of polythene, such as 0·002 in. thickness, have been claimed to be more satisfactory than tissue or cellophane paper wraps. However, not all importers favour the use of polythene.

For export, South African avocado pears must be packed and graded to conform to the regulations promulgated under the Fruit Export Act of 1914 and published in the *Government Gazette*, No. 5722, dated 27th July, 1956. These regulations require that:

(a) Avocado pears shall be packed in single layer clean new trays 18 in. long and 12 in. wide.

(b) Each fruit shall be wrapped in paper, cellophane or other suitable material and surrounded by wood wool.

(c) The trays shall have a thick layer of wood wool on the bottom and along the sides and ends as well as a sheet of paper and a thick layer of wood wool between paper and lid.

(d) The fruit shall be cut from the tree and from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. of the stalk shall be left on the fruit.

(e) All "Selected" grade avocados shall be in sound condition, true to variety, uniform in size, fully developed, mature but not overripe, clean and free from injury, disease, insect infestation, and other blemishes detrimentally affecting their appearance.

(f) All "Choice" grade avocados shall be in sound condition, true to variety, uniform in size, fully developed, mature but not overripe, clean and free from injury, disease, insect infestation, and reasonably free from other blemishes detrimentally affecting their appearance.

(g) The fruit shall be packed diagonally in the tray. No tray shall contain more than 16 fruits and the pack shall be firm.

Avocado pears are very susceptible to chilling injuries and are therefore a difficult fruit to ship under cold storage. In American literature, a carrying temperature of between 40°F. and 45°F. is widely recommended, while it is understood that the South African fruit is shipped to the United Kingdom at a temperature of 46°F. to 48°F. However, at these temperatures chilling injuries may result and it has been suggested that a temperature of 50°F. is safer. Any new exporter would undoubtedly have to carry out a considerable amount of preliminary work to determine the best shipping temperature, since variety, local climatic conditions and the length of time fruit is kept under cold storage will affect its keeping qualities.

D.E.K.

Book Reviews

POTATO PROCESSING. By W. F. Talburt and O. Smith. xv + 475 pp., 9 × 6. (The Avi Publishing Company, Inc., Westport, Connecticut, 1959.) Price $10.50.

The potato, with a total production at present in excess of 4,000 million hundredweights, is one of the major food crops of the world and the processing of the crop is almost as old as the utilization of the tuber itself. In the United States the processing of potatoes has developed rapidly since the end of the war and *per capita* consumption of processed potatoes was 23·4 lb. in 1956, compared with 1·9 lb. in 1940. Although almost 70 per cent. of the potatoes processed are consumed as chips in that country, dehydrated and frozen potato products are becoming increasingly important.

This book, stated to be the first in its field, reviews all aspects of the American potato processing industry and in the 20 chapters, each contributed by a specialist, the whole subject is adequately covered from the production of the crop in the field to the finished product as used by the consumer. In this thorough coverage of the subject, the structure and the chemical composition of potato tubers are discussed at length, the many varieties grown in North America are described and evaluated; the cultivation of the crop, the harvesting, transport and storage of the tubers, are all dealt with in detail, particularly the control of various potato diseases and the use of chemicals to inhibit sprouting. All this information is presented in relation to the quality of the various products processed and, in this connection, it is interesting to note the importance of storage temperatures on the processing quality of potatoes, particularly when these are utilized for the production of chips.

The nutritive value of potatoes is discussed at length and the importance of this foodstuff as a source of vitamin C is emphasized. Reference is also made to the possible function of potatoes in the diet to prevent dental decay.

With regard to the processing of potatoes, detailed descriptions are given of the methods used to produce the various types of potato products and special attention has been given to the problems likely to be encountered by processors. The chapters dealing with the production of potato starch and potato flour are likely to be of particular interest in those countries where the tubers are produced and where there are unlikely to be considerable outlets for processed products such as chips, frozen French fries and pre-peeled potatoes. These chapters not only review the processing methods used for the production of potato starch and flour but include particulars of the outlets which exist for these products on the American market.

Each chapter of this comprehensive work concludes with a bibliography, and, although the majority of papers quoted refer to work in the United States, it is interesting to note that in the chapter dealing with the production of canned white potatoes mention is made of several papers by the British workers, F. Hirst and W. B. Adam. In addition, numerous clear diagrams and photographs illustrate the text, particularly the sections dealing with processing methods and equipment. As a whole, this work is a most useful review of the processing of potatoes, emphasizing their versatility as a food crop.

For the practical worker, a useful account of the methods used to determine the total solids content of raw potatoes and a colorimetric method for determining reducing sugars with sodium 2·4 dinitrophenolate, is included in an appendix. D.E.K.

UNITED KINGDOM MEAT TRADE ANNUAL AND DIRECTORY OF ANIMAL BY-PRODUCTS, 1959, 567 pp., 9 × 5½. (London: Wheatland Journals Ltd.) Price 21*s*.

This comprehensive reference book is a complete guide to the United Kingdom meat trade. It contains details of trade organizations, analyses of imports and

exports and classified guides to manufacturers, shippers and distributors in all branches of the meat trade. There are eight sections, viz.: Livestock, Meat, Canned and Cooked Meat, Quick-Frozen Meat and Poultry, Game and Poultry, (Section 1); Hide and Skin Shippers (Section 2); Sausages, Ingredients, Casing (Section 3); Plant Equipment and Butchers' Sundries (Section 4); Refrigeration, Cold Storage, Packing, Shipping, Transport (Section 5); Deadweight Centres, Hygiene Regulations for Slaughterhouses (Section 6); Self Service Operators, Retail Butchers, Pork Butchers (Section 7); Brand Names and Trade Names, Overseas Supplies, Indices (Section 8). Each of these sections is readily located by printed tags which project at the side of the book.

L.H.G-B.

THE EMPIRE AND COMMONWEALTH YEAR BOOK, 1959-60. Edited by Ronald S. Russell. Eighth Edition, xxvi + 606 pp., $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Newman Neame Ltd.) Price 50*s*. net.

This important work of reference, which is revised annually, contains a wealth of detailed information relating to all the 80 countries and territories which make up the British Commonwealth and Empire. Facts concerning a wide range of subjects including government, history, population, trade and industrial development are set out clearly and concisely for quick and easy reference. The volume is in three parts, the last being devoted entirely to more than 90 raw materials and commodities with statistics of production, imports and exports in each case. This information is presented in a form most useful to traders and manufacturers.

The many official and unofficial organizations concerned with Commonwealth affairs are described. New features of the current edition are a section on the United Kingdom Board of Trade, a more comprehensive one on the Commonwealth Parliamentary Association and a brief account of the sterling area.

M.K.

PERFUMES, COSMETICS AND SOAPS, with special Reference to Synthetics. By William A. Poucher, F.P.S., F.R.P.S. Volume II, being a Treatise on the Production, Manufacture and Application of Perfumes of all types. Seventh Edition, 1959. xii + 453 pp. $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Chapman & Hall, Ltd.) Price 75*s*.

The second volume of this work, devoted to perfumery, retains the general arrangement of the earlier editions but differs from them in several important respects. The book has been extensively revised and Chapter 5, containing monographs on flower perfumes, which comprises about two-fifths of the text, has been to a great extent re-written.

New material in the book includes references to the extraction of flower oils with butane, a process which was developed, and has now been operated for several years, by a well-known Grasse firm; to the successful cultivation of jasmin in Algeria and Morocco and to the production of rose otto in the latter country. During the Second World War, Bulgarian rose otto was unobtainable and since then its production has not reached pre-war levels. In consequence, Turkish rose otto from Anatolia, though an article of lower odour quality, has attained much greater importance as one of the perfumer's raw materials; the author has recognized the fact by the inclusion of a description of the Anatolian industry, written at first hand by his colleague, J. Hackforth-Jones.

The most noteworthy feature of the new edition, however, is the inclusion in Chapter 4 of the author's own system of odour classification. This is based on the determination of the comparative volatilities of a large number of natural and synthetic perfumery materials. The volatilities were measured as the length of time for which each substance, when applied to a smelling strip under roughly controlled conditions, retained its characteristic odour. The results were then arranged in ascending order on an arbitrary scale of from 1 to 100; the substances with 'coefficients' from 1 to 14, i.e. the most volatile, are called the 'Top Notes', those from 15 to 60 the 'Middle Notes' and the others from 61 to 100 the 'Basic Notes' or 'Fixers'.

This classification, as the author states, may need to be modified in the light of improvements in the production, processing and purification of aromatics, but even in its present state it possesses the advantage over all previously propounded classifications that it is eminently practical; it provides a means of systematizing, so far as this can be done, the difficult art of perfumery compounding. It is certain to be of interest and value to every perfumer whether expert or novice.

Inclusion of this classification in the new edition has necessitated a sweeping revision of the monographs on flower perfumes. In each case the paragraphs on 'Compounding Notes' and 'Synthetic Components' in the old edition have been replaced in the new one by a tabulated list of components divided into 'Top Notes', 'Middle Notes' and 'Basic Notes', in accordance with the author's classification, followed by new compounding notes. The appended formulae provided as illustrations are also new. The toilet waters, Eau de Cologne and lavender, and the soap perfumes have been treated similarly.

This volume contains few errors, but it is to be regretted that the word 'stearophene' (instead of 'stearoptene') which appeared on page 97 of the sixth edition is still to be found in the new edition on page 95. The references have been tidied up to some extent by italicizing journal titles, using mostly the abbreviations of the *World List*, but it is a pity that this process was not completed by adopting the system recommended by the Chemical Society or the American Chemical Society.

E.B.

RECEIVED FOR NOTICE

SOIL AND LAND-USE SURVEYS, No. 6. Report by the Regional Research Centre of the British Caribbean. 24 pp., Maps, 10½ × 8. (Trinidad: The Imperial College of Tropical Agriculture, June, 1959.) Price 15*s*.

Survey No. 6 deals with British Guiana and reports on the physical environment and soils of the Northern Rupununi Savannas and of the Intermediate Savannas. One of the facts emphasized is that all the soils in the area are very low in mineral nutrients and that, where it is decided to undertake agricultural development, heavy fertilizer additions will be required to maintain plant growth.

SOIL AND LAND-USE SURVEYS, No. 7. Report by the Regional Research Centre of the British Caribbean. 33 pp., Maps, 10½ × 8. (Trinidad: The Imperial College of Tropical Agriculture, June, 1959.) Price 20*s*.

Survey No. 7 deals with Jamaica and reports on the soils of the Parish of Clarendon and on factors affecting land-use in the parish. Lines of investigation and research around which an improved land-use programme could be orientated are suggested.

WEST AFRICAN COTTON RESEARCH CONFERENCE, November, 1957, v + 209 pp., 11 × 8½. (Nigeria: The Ministry of Agriculture, 1959.) Price 15*s*.

The Conference which is the subject of this report is one of a series held in West Africa for the exchange of scientific knowledge concerning tropical agricultural problems. It was attended by delegates from French, Belgium and Portuguese colonial territories and by representatives of Ghana and Nigeria. The full texts of the 33 papers, dealing with all aspects of the problems of cotton cultivation, are given and the main points made in informal discussions are also reported.

Bibliography

Compiled by Miss V. Clarke

Comprising the more important reports, articles, etc., contained in publications received in the Library during the three months from October to December 1959.

*The publications issued by the Governments of the Colonies and Protectorates can be obtained from or through the Crown Agents for Overseas Governments and Administrations, 4 Millbank, Westminster, S.W.*1. *Applications for Dominion, Northern and Southern Rhodesian Government publications may be made to the Offices of the High Commissioners or Agents-General in London.*

Publications of the U.S Departments of Agriculture and Commerce are obtainable from Superintendent of Documents, U.S. Government Printing Office, Washington 25, *D.C., U.S.A., or from H. M. Stationery Office, London.*

F.A.O. publications are obtainable from the Food and Agriculture Organization of the United Nations, Washington 25, *D.C., U.S.A., or from H. M. Stationery Office, London.*

Agriculture

Report of the Rothamsted Experimental Station for 1958. 283 pp. (Harpenden: Rothamsted Experimental Station, 1959). Price 10*s.* post free.

Report, Welsh Plant Breeding Station, 1st October 1956 to 30*th September* 1958. 80 pp. (Aberystwyth: Welsh Plant Breeding Station, 1959). Price 7*s.* 6*d.*

Report of the Department of Agriculture, Ceylon, for 1958. 216 pp. (Colombo: Government Publications Bureau, 1959). Price 5/40. Postage –/55.

Agriculture and Economic Development in India. By P. Maheshwari and S. L. Tandon. *Econ. Bot.*, 1959, **13,** No. 3, 205-42.

Economic Potential of Malaya. By T.H.S. Agricultural Research in Malaya. By J. K. Coulter. *Research, Lond.*, 1959, **12,** No. 12, 447-49 and 450-54.

Report, Department of Agriculture, New Zealand, for the Year ended 31*st March* 1959. 174 pp. (Wellington: Government Printer, 1959).

Report, East African Agriculture and Forestry Research Organization, for the Period 1st January to 31*st December* 1958. 109 pp. (Nairobi: Government Printer, 1959). Price Sh. 3/50.

Report of the Secretary to the Ministry of Agriculture, Federation of Rhodesia and Nyasaland for the Year ended 30*th September* 1958. 215 pp. (Salisbury: Government Printer, 1959). Price 10*s.* 6*d.*

Commerce and Industry in Kenya, 1959. *Publ. Min. Comm. and Ind.*, 1959. 109 pp. (Nairobi: Government Printer, 1959). Price Sh. 2.

Kenya, Survey of Industrial Production, 1957. *Publ. East African Statistical Department, Kenya Unit.* 88 pp. (Nairobi: Government Printer, 1959). Price Sh. 7.

Report of the Department of Agriculture, Western Region, Nigeria, for the Year 1953-54. *Sess. Pap. No.* 6, 1959. 49 pp. (Western Region, Nigeria: Government Printer, 1959). Price 9*d.*

Progress Report on the Development of the Western Region of Nigeria, 1955-60. *Sess. Pap. No.* 4 *of* 1959. 42 pp. (Western Region, Nigeria: Government Printer, 1959). Price 1*s.*

Report, Department of Agriculture, Nyasaland, for the Year 1957/8. *Part II.* 155 pp. (Zomba: Government Printer, 1959). Price 7*s.*

Report of the Department of Agriculture, Sierra Leone, 1957. 42 pp. (Freetown: Government Bookshop, and Crown Agents, 1959). Price 3*s.* 6*d.*

Report, Water Development and Irrigation, Tanganyika, 1958. 39 pp. (Dar es Salaam: Government Printer, 1959). Price Shs. 7/50.

Report, Department of Agriculture, Tanganyika, 1958, *Part I.* 41 pp. (Dar es Salaam: Government Printer, 1959). Price Shs. 4.

Report of the Department of Agriculture, Uganda, for the Year ended 31*st December,* 1958. 75 pp. (Entebbe, P.O. Box 33: Government Printer, 1959). Price Shs. 5.

Report of the Marketing Department, Jamaica, for the Year ended 31st March 1958. 8 pp. (Kingston: Government Printer, 1959). Price 2*s.*

Agricultural Statistics, the West Indies, Series 1. *The* 1956-58 *Surveys. No.* 5. *The Survey in St. Vincent.* 39 pp. (Federal House, Port of Spain: Ministry of Natural Resources and Agriculture, 1959). Price 15 *cents.*

Report of the Department of Agriculture, Trinidad and Tobago, for the Year 1957. 49 pp. (Trinidad: Government Printing Office, 1959). Price 60*c.*

Report, Department of Agriculture, North Borneo, for the Year 1958. By E. J. H. Berwick. 46 pp. (Jesselton: Government Printing Department, 1959). Price $2.00 or 4*s.* 6*d.*

British North Borneo. A Review of the Colony with Special Reference to Agricultural Development and Opportunities for Investment in Agricultural Enterprise. By D. H. Urquhart. *Publ. Cadbury Brothers Ltd.*, 1959. 38 pp. (Bourneville, U.K.: Cadbury Brothers Ltd., 1959). Price 5*s.*

Report of the Department of Agriculture, Cyprus, for the Year 1958. 64 pp. (Nicosia: Government Printing Office, 1959).

Report of the Department of Agriculture, Sarawak, for the Year 1958. By J. Cook. 68 pp. (Kuching: Government Printer, 1959). Price $2.00.

Report of the Department of Agriculture, Seychelles, for the Year 1958. 22 pp. (Victoria–Mahé: Government Printer, 1959).

Report, Department of Agriculture, Fiji, for the Year 1958. *Counc. Pap. No.* 9 *of* 1959. 16 pp. (Suva: Government Press, 1959). Price 1*s.* 6*d.*

Crops Research in the Soviet Union. Report of a Technical Study Group. *Agric. Res. Serv., U.S. Dep. Agric.*, 1959. 26 pp. (Washington 25, D.C.: Government Printing Office, 1959). Price 25 *cents.*

Report of the Florida Agricultural Experiment Station for the Fiscal Year ending 30th June, 1958. 411 pp. (Gainsville: University of Florida).

Report of the Deir Alla Research Station, Jordan, 1958. 73 pp. (Amman: Director of Agriculture, 1959).

The State of Food and Agriculture, 1959. *Publ. F.A.O.* 197 pp. Price $2.00 or 10*s.*

Beverages

The Viruses of *Cacao.* By J. M. Thresh and T. W. Tinsley. *Tech. Bull. No.* 7, *West African Cocoa Research Institute,* 1959. 32 pp. (London: Crown Agents, 1959). Price 2*s.* 6*d.*

Administration Report of the Cocoa Board, Trinidad and Tobago, for the Year 1957. 42 pp. (Trinidad: Government Printing Office, 1959). Price 60*c.*

Cocoa-Growing in Venezuela, Colombia and Ecuador with Notes on Three Cocoa Diseases. By G. A. R. Wood. *Publ. Cadbury Brothers Ltd.*, 1959. (Bourneville, U.K.: Cadbury Brothers Ltd., 1959).

Tea Manufacture in Ceylon. By E. L. Keegel. *Monographs on Tea Production in Ceylon, No.* 4. 179 pp. (Colombo: Tea Research Institute of Ceylon, 1958). Price Rs. 7/50.

Cereals

Control of Weaver Bird in West Africa. By A. Mallamaire. *FAO Plant Prot. Bull.*, 1959, **7,** No. 8, 105-112.

FAO Commodity Reports. Rice No. 10, 1959. 67 pp. (Rome: FAO/59/8/6206). Price U.S. $0.25–1*s.* 3*d.*

Drugs

Australian Phytochemical Survey. III. Saponins in Eastern Australian Flowering Plants. *Bull. sci. ind. Res. Org., Melbourne, No.* 281, 1959. 31 pp.

Travaux des Laboratoires de Matière Médicale et de Pharmacie Galénique de la Faculté de Pharmacie de Paris, Tome XLII, 1958. (Paris: Vigot Frères, 1959). Papers on various drug plants including *Rauwolfia* spp.

Recent Highlights in the Chemurgy of Xerophytic Plants. By R. R. Cruse. *Econ. Bot.*, 1959, **13,** No. 3, 243-60.

The Cardiac Glycosides of *Digitalis.* By A. Stoll. *Chem. & Ind.*, 1959, No. 50, 1558-67.

Essential Oils

Lemongrass Oil from Ceylon. By M. G. De Silva. *Mfg Chem.*, 1959, **30**, No. 10, 415-16.

Fibres

Progress Reports from Experiment Stations, Seasons 1957-58. *Survey of Reports.* 11 pp. *Kenya.* 7 pp. *Tanganyika Territory, Eastern Province.* 18 pp. *Tanganyika Territory, Lake Province.* 20 pp. (London: Empire Cotton Growing Corporation, 1959).

Fish

Progress Report of the Atlantic Coast Stations, Fisheries Research Board of Canada, No. 72, 1959. 39 pp. (St. Andrews, N.B.: Director, Atlantic Biological Station, 1959).

Progress Reports of the Pacific Biological Station, Nanaimo, B.C., and Technological Station, Vancouver, B.C., No. 113, 1959. 19 pp. (Ottawa: Queen's Printer, 1959).

Report of the Fisheries Branch, Mauritius, for 1957. *No.* 1 *of* 1959. 29 pp. (Port Louis: Fisheries Officer, 1959).

Market Survey on Canned and Frozen Sea Foods in France. *Market Survey Series No.* 20, *Ministry of Commerce and Industry, Government of India.* 10 pp. (Simla: Government Press, 1959).

Yearbook of Fishery Statistics, 1957. Vol. VIII. International Trade. *Publ. F.A.O.*, 1959. Price $4.00, 20*s*.

The Pacific Crab Canning Industry of British Columbia—I and II. By E. B. Dewberry. *Food Manuf.*, 1959, **34**, No. 11, 425-29; No. 12, 474-77.

Foodstuffs

Report of the Glasshouse Crops Research Institute, 1958. 94 pp. (Rustington, Sussex: Glasshouse Crops Research Institute, 1959). Price 10*s*.

Storage of Yams. Part I. Investigation on Weight Changes. *Publ. West African Stored Products Research Unit.* (Lagos, Nigeria: Federal Government Printer, 1959).

Forestry

Report of the Forestry Commissioners for the Year ended 30th September 1958. 84 pp. (London: H. M. Stationery Office, 1959). Price 5*s*. net.

Code of Sample Plot Procedure. By F. C. Hummel *et al. Bull For. Comm., Lond., No.* 31. 113 pp. (London: H. M. Stationery Office, 1959). Price 15*s*. net.

Report on Forest Administration, Federation of Malaya, for the Year 1958. By J. S. Smith. 110 pp. (Kuala Lumpur: Government Press, 1959). Price $2.50.

Report of the Forest Department, Kenya, 1958. 53 pp. (Nairobi: Government Printer, 1959). Price Sh. 4.

Report, Forestry Department (Administration), Northern Region of Nigeria, for the Year 1957-58. 46 pp. (Kaduna: Government Printer, 1959). Price 2*s*. net.

Report on the Forest Administration of the Western Region of Nigeria for the Year 1956-57. *Sess. Pap. No.* 9, 1958. 34 pp. (Western Region, Nigeria: Government Printer). Price 1*s*.

Report, Forest Department, Tanganyika Territory, for the Year ended 31st December 1958. 48 pp. (Dar es Salaam: Government Printer, 1959). Price Shs. 5/50.

Report of the Forest Department, Uganda, for the Year ended 31st December 1958. 80 pp. (Entebbe, P.O. Box 33: Government Printer, 1959). Price Shs. 6.

Report, Forest Department, British North Borneo, 1958. 71 pp. (Jesselton: Government Printer, 1959). Price $3.00.

Report of the Forest Administration in Cyprus for the Year 1958. 63 pp. (Nicosia: Government Printing Office, 1959).

Fruits

Report of the Agricultural and Horticultural Research Station, University of Bristol, Long Ashton, 1958. 188 pp. (Long Ashton, Bristol: National Fruit and Cider Institute). Price 15*s*. post free.

California Avocado Yearbook 1959. *Vol.* 43. 126 pp. (Los Angeles 58: California Avocado Society, 1959).

Report of the Department of Agriculture, Cyprus, for 1958. *Annexure III. Report on Viticulture.* By Ph. Vryonides. 5 pp. (Nicosia: Government Printing Office, 1959).

Brown Stem of Oranges Investigation. By R. A. DeFossard. *Bull. Minist. Agric., Jamaica, No.* 56, *N.S.*, 1959. 160 pp.

Gums

Market Survey on Shellac and other Gums in Australia. *Market Survey Series No.* 22, *Ministry of Commerce and Industry, Government of India.* 7 pp. (Simla: Government Press, 1959).

Insect Pests and Insecticides

Pest Infestation Research 1958. *Report of the Pest Infestation Research Board with the Report of the Director of Pest Infestation Research.* 55 pp. (London: H. M. Stationery Office, 1959). Price 5*s.* net.

Report of the Colonial Pesticides Research Unit, Arusha, Tanganyika, East Africa, for 1958-59. (*Progress Report No.* 24). 28 pp. (Dar es Salaam: Government Printer, 1959). Price Shs. 5.

Biological Control of Insect Pests in Bermuda. By F. D. Bennett. *Bull. ent. Res.*, 1959, **50,** Part 3, 423-36.

Relative Toxicity to Mammals of 40 Pesticides. By S. H. Kerr and J. E. Brogdon. *Agric. Chemic.*, 1959, **14,** No. 9, 44-45, 135.

Bibliographie der Pflanzenschutz-Literatur, 1952. (Bibliography of Plant Protection). *Publ. Biol. Reichsanst. f. Land-u. Forstwirschaft*, 1959. 433 pp. (Berlin: Paul Parey, SW61, Lindenstrasse, 44-47, West Berlin).

Immature Nutfall of Coconuts in the Solomon Islands. I. Distribution of Nutfall in Relation to that of *Amblypelta* and to Certain Species of Ants. II. Changes in Ant Populations, and their Relation to Vegetation. III. Notes on the Life-history and Biology of *Amblypelta.* By E. S. Brown. *Bull. ent. Res.*, 1959, **50**; Part I, 97-133, and Part III, 523-58 and 559-66.

Prophylactic Efficacy of Various Insecticides in the Protection of Freshly Felled and Converted Timbers (Planks) against Insect Borers. By M. L. Roonwal *et al. Ind. For. Bull. No.* 215, *N.S.* 45 pp. (Simla: Government of India Press, 1959). Price Rs. 4.12 nP or 6*s.* 6*d.*

The Fruit-piercing Moths of the Genus *Gonodonta* Hübner. By E. L. Todd. *Tech. Bull. U.S. Dep. Agric. No.* 1201, 1959. 52 pp. (Washington: Agricultural Research Service, 1959).

Plant Nematodes. Their Bionomics and Control. By J. R. Christie. *Publ. Univ. Florida agric. Exp. Stat.*, 1959. 256 pp. (Gainsville, Florida: Agricultural Experiment Station, 1959).

Pyrethrum Mists and Aerosols for Control of Insects in Tobacco Warehouses. By J. N. Tenhet. *Mktg Res. Rep., U.S. Dep. Agric., No.* 334. 21 pp. (Washington: Government Printing Office, 1959). Price 15 *cents.*

Livestock and Animal Products

Report, Veterinary Department, Kenya. 1958. 99 pp. (Nairobi: Government Printer, 1959). Price Sh. 5.

Report, Veterinary Department of Northern Rhodesia, 1958. 16 pp. (Lusaka: Government Printer, 1959). Price 2*s.* 6*d.*

Report of the Veterinary Department, Uganda, for the Year ended 31st December, 1958. 52 pp. (Entebbe, P.O. Box 33: Government Printer, 1959). Price Shs. 3/60.

By-Products of the Meat Packing Industry. *Publ. Institute of Meat Packing.* 418 pp. (University of Chicago, Illinois: Institute of Meat Packing, 1958).

Oils, Oilseeds and Waxes

Vegetable Oils and Oilseeds. A Review of Production, Trade, Utilization and Prices relating to Groundnuts, Cottonseed, Linseed, Soya Beans, Coconut and Oil Palm Products, Olive Oil and Other Oilseeds and Oils. *Publ. Commonw.*

econ. Comm., 1959. 207 pp. (London: H. M. Stationery Office, 1959). Price 10*s.* net.

Annual Review for 1958 *of Oilseeds, Oils, Oilcakes and Other Commodities.* 85 pp. (London: Frank Fehr & Co., Limited, 1959).

Literature Review on Oils and Fats, 1956. By B. Y. Rao. *Publ. Counc. sci. ind. Res., New Delhi.* 74 pp. (Mysore: Central Food Technological Research Institute, 1958).

Capacity and Processing Trends in the Fats and Oils Industry. By J. D. Peier and C. B. Gilliland. *Mktg Res. Rep. U.S. Dep. Agric., No.* 360. 43 pp. (Washington: Government Printing Office, 1959). Price 25 *cents.*

Experimental Investigation of *Crambe abyssinica* Hochst. (Abyssinian Kale)—a New Oilseed Plant in Leningrad Oblast. By A. E. Grashchenkov. *Botanical Journal, U.S.S.R.*, 1959, **44**, No. 4, 536-43.

The Stem Rot of Peanuts and its Control. By K. H. Garren. *Tech. Bull. Va agric. Exp. Sta No.* 144, 1959. 29 pp. (Washington: Agricultural Research Service, 1959).

Pulp, Paper and Board

The Pulp and Paper Industry in Europe. A Report by the Pulp and Paper Committee, OEEC. 68 pp. + tables. (Paris: Organisation for European Economic Co-operation, 1959). Price 10*s.* 6*d.*, $1.50, 700 F.fr., 7 Sw.fr., 6 DM.

Rubber

Report, British Rubber Producers' Research Association, 1958. 50 pp. (London: British Rubber Producers' Research Association, 1959).

Report, Rubber Research Institute, Ceylon, 1958. 129 pp. (Colombo: Rubber Research Institute, 1959).

Report of the Rubber Research Institute of Malaya, 1957. 95 pp. (Kuala Lumpur: Rubber Research Institute). Price $3.

Soils

Soils of Chatham Island (Rekohu). By A. C. S. Wright. *Soil Bur. Bull. No.* 19, *N.Z.* 60 pp. (Wellington: Government Printer, 1959).

Soil and Land-Use Surveys. No. 4. Jamaica. By K. C. Vernon and T. A. Jones. 28 pp. + map. No. 5, British Guiana. By J. Stark *et al.* 34 pp. + map. *Publ. Regional Research Centre, British Caribbean.* (Trinidad: Imperial College of Tropical Agriculture, 1959). Price No. 4, 12*s.* 6*d.* No. 5, 14*s.*

Sugar

Sugar (Pocket) Year Book, 1958. 198 pp. (London: International Sugar Council, 1959). Price 10*s.*

The Indian Sugar Industry (1957-58 *Annual*), *Vol.* 22, 1959. 350 pp. (Bombay: M. P. Gandhi, Jan Mansion, Sir P. M. Road, 1959). Price Rs. 6; V.P.P. Rs. 7.

Controlled Pollination of Sugar Cane. By J. C. Skinner. *Tech. Commun. Bur. Sug. Exp. Stas Qd*, 1959, *No.* 1. 20 pp. (Brisbane: Sugat Experiment Stations Board, 1959).

Sugar in the West Indies and British Guiana. *British West Indies Sugar Association Handbook*, 1958. 96 pp. (Bridgetown, Barbados: British West Indies Sugar Association (Inc.)).

Report, British West Indian Central Sugar Cane Breeding Station, Barbados, 1957-58. 44 pp. (Bridgetown: Advocate Co. Ltd.).

Tanning Materials

Report, Wattle Research Institute, University of Natal, for 1958-59. 51 pp. (Pietermaritzburg: Wattle Research Institute, 1959).

Tanning Extracts from Canaigre Roots. By E. L. Griffin *et al. Publ. Agric. Res.*

Serv., U.S. Dep. Agric. 29 pp. (Philadelphia 18, Pa: Eastern Utilization Research and Development Division, 1959).

TOBACCO

Estudios Genéticos sobre la Combustibilidad del Tabaco. (Genetic Studies on Combustibility of Tobacco). By E. A. Mira. *An. Inst. nac. Invest. agron. Madr.*, 1959, **8**, No. 2, 699 pp. Price 75 pesetas.

© *Crown copyright 1960*

Published by
HER MAJESTY'S STATIONERY OFFICE

To be purchased from
York House, Kingsway, London W.C.2
423 Oxford Street, London W.1
13A Castle Street, Edinburgh 2
109 St. Mary Street, Cardiff
39 King Street, Manchester 2
Tower Lane, Bristol 1
2 Edmund Street, Birmingham 3
80 Chichester Street, Belfast 1
or through any bookseller
Price 12*s.* 0*d.* net

Annual Subscription 26*s.* 0*d.* including postage

PRINTED IN ENGLAND UNDER THE AUTHORITY OF HER MAJESTY'S STATIONERY OFFICE BY A. BROWN AND SONS LTD. LONDON AND HULL.

Wt.P8523-K12 Gp. 1215

COLONIAL ADVISORY COUNCIL OF AGRICULTURE, ANIMAL HEALTH AND FORESTRY PUBLICATIONS

The Improvement of Cattle in British Colonial Territories in Africa

A survey with recommendations for the solution of problems connected with cattle in British Colonial Territories in Africa. The report is of special interest at the present time, since in the interests of African peoples and of the economies of their territories it is becoming increasingly important that African livestock should be improved. Although the survey was of African territories the information and conclusions should be of value to all tropical and sub-tropical territories. (No. 3.) **10s. 6d.** (*post* 7d.)

The Indigenous Cattle of the British Dependent Territories in Africa

Complementary to the above, this report describes the distinctive types and breeds of indigenous cattle found in the territories surveyed, together with Southern Rhodesia, the High Commission territories, Libya, and Sudan. In addition to text figures and maps there are 60 pages of photographs and a full bibliography. (No. 5.)

30s. (post 10d.)

Obtainable from

HER MAJESTY'S STATIONERY OFFICE

at the addresses on page 114 or through any bookseller

Serv., U.S. Dep. Agric. 29 pp. (Philadelphia 18, Pa: Eastern Utilization Research and Development Division, 1959).

TOBACCO

Estudios Genéticos sobre la Combustibilidad del Tabaco. (Genetic Studies on Combustibility of Tobacco). By E. A. Mira. *An. Inst. nac. Invest. agron. Madr.*, 1959, **8,** No. 2, 699 pp. Price 75 pesetas.

© *Crown copyright 1960*

Published by
HER MAJESTY'S STATIONERY OFFICE

To be purchased from
York House, Kingsway, London W.C.2
423 Oxford Street, London W.1
13A Castle Street, Edinburgh 2
109 St. Mary Street, Cardiff
39 King Street, Manchester 2
Tower Lane, Bristol 1
2 Edmund Street, Birmingham 3
80 Chichester Street, Belfast 1
or through any bookseller
Price 12*s.* 0*d.* net

Annual Subscription 26*s.* 0*d.* including postage

PRINTED IN ENGLAND UNDER THE AUTHORITY OF HER MAJESTY'S STATIONERY OFFICE BY A. BROWN AND SONS LTD. LONDON AND HULL.

Wt.P8523-K12 Gp. 1215

COLONIAL ADVISORY COUNCIL OF AGRICULTURE, ANIMAL HEALTH AND FORESTRY PUBLICATIONS

The Improvement of Cattle in British Colonial Territories in Africa

A survey with recommendations for the solution of problems connected with cattle in British Colonial Territories in Africa. The report is of special interest at the present time, since in the interests of African peoples and of the economies of their territories it is becoming increasingly important that African livestock should be improved. Although the survey was of African territories the information and conclusions should be of value to all tropical and sub-tropical territories. (No. 3.) **10s. 6d.** (*post* 7d.)

The Indigenous Cattle of the British Dependent Territories in Africa

Complementary to the above, this report describes the distinctive types and breeds of indigenous cattle found in the territories surveyed, together with Southern Rhodesia, the High Commission territories, Libya, and Sudan. In addition to text figures and maps there are 60 pages of photographs and a full bibliography. (No. 5.)

30s. (post 10d.)

Obtainable from

HER MAJESTY'S STATIONERY OFFICE

at the addresses on page 114 or through any bookseller

A Service in Government Publications

Her Majesty's Stationery Office, publishers of this journal, offer its readers a comprehensive service which will enable them to judge whether any other titles in the vast output of Government Publications would help them in their work or leisure.

Catalogues are published daily, monthly and annually; in the latter two cases, Statutory Instruments are omitted, and separate catalogues for these are published. In addition, numerous sectional catalogues, issued free of charge, list the publications sponsored by individual Government Departments, and in some cases lists covering special subjects are available.

You can obtain full information about this service by sending a postcard to Sales Promotion (HMSO), Room D.42, Atlantic House, Holborn Viaduct, London EC1, asking for our CATALOGUE SERVICE LEAFLET.

Ask at the same time for the name and address of your nearest official agent for Government Publications.

HMSO

Publishers to Her Majesty's Government

S.O. Code No. 82-31-60-2